IBM Customer Engineering

Instruction-Maintenance

729 II, V Magnetic Tape Units (30,000 Series)

729 IV, VI Magnetic Tape Units (90,000 Series)

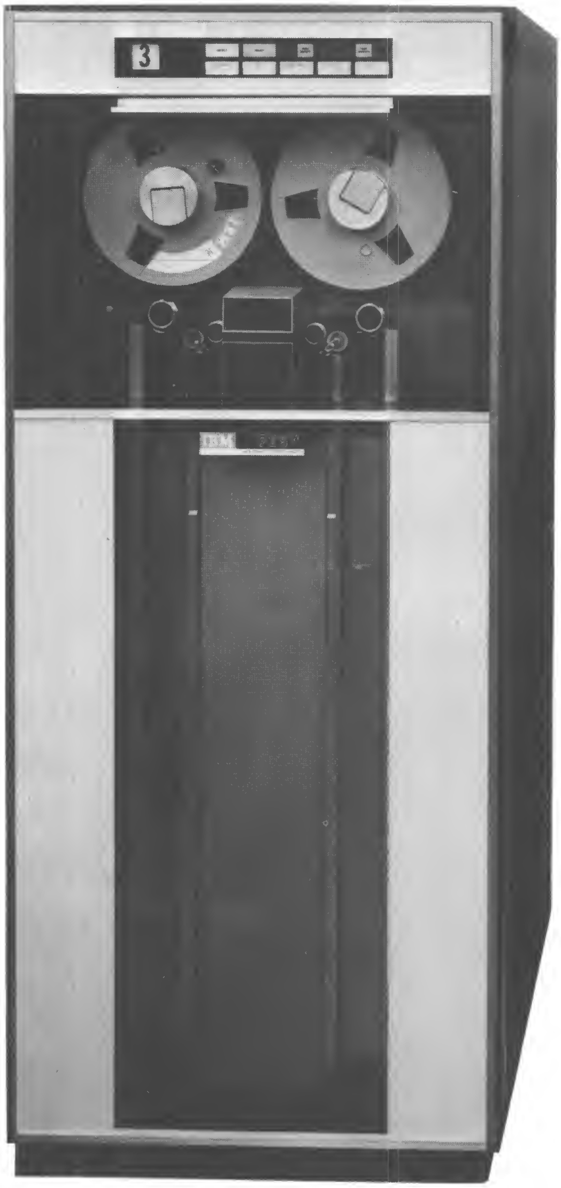
IBM® Customer Engineering

Instruction-Maintenance

729 II, V Magnetic Tape Units (30,000 Series)

729 IV, VI Magnetic Tape Units (90,000 Series)

Preface



IBM 729 VI Magnetic Tape Unit

This manual describes the theory of operation and servicing procedures for IBM 729 II and V (30,000 series), and IBM 729 IV and VI (90,000 series) Magnetic Tape Units. These tape units utilize NOR transistor logic in place of much of the relay circuitry formerly used in tape handling circuits. They are fully compatible with 729 II, IV, V, and VI NORLAY and relay machines.

The manual covers theory of storing information on magnetic tape, mechanical operating principles, circuit logic, and operation of a few special component circuits used in the tape units. Material covering scheduled maintenance, removal and replacement of components, and adjustments is also included, as well as sequence and condensed logic charts.

In general, this manual applies to 729 II, IV, V, and VI Magnetic Tape Units. Significant differences between these models are pointed out in the text, and specific features of the 729 V and VI Magnetic Tape Units are explained in the final section.

Other IBM 729 Magnetic Tape Units are described in the following manuals:

Relay Units

Customer Engineering Manual of Instruction, IBM 729 II, 729 III, 729 IV Magnetic Tape Units, Form 223-6845.

Customer Engineering Reference Manual, IBM 729 II, III, IV Magnetic Tape Units, Form 223-6868.

NORLAY Units

Customer Engineering Instruction-Maintenance Manual, IBM 729 II, V, Magnetic Tape Units (12,000 Series) IBM 729 IV, VI Magnetic Tape Units (61,000 Series), Form 223-2740.

Serial number assignments for NOR, NORLAY, and relay tape units are explained on page 7 of this manual.

Engineering changes may alter specifications, logic, and machine functions, causing a tape unit to differ from the description presented here.

MAJOR REVISION (May, 1964)
This edition, Form 223-6988-3, is a major revision of Form 223-6988-2. Sections on Basic Circuit Functions and Machine Operations have been rewritten and sequence charts redrawn to correspond to the EC level of machines described in Instructional Systems Diagrams, Form 223-2509-1, and photographs of latest production IBM 729 NOR Magnetic Tape Units have been incorporated. New or revised figures are indicated by a bullet (●) adjacent to the figure title. New or revised text is indicated by a bullet adjacent to the Table of Contents listing.

Copies of this and other IBM publications can be obtained through IBM Branch Offices.
Address comments concerning the content of this publication to:
IBM Corporation, CE Manuals, Dept. B96, PO Box 390, Poughkeepsie, N. Y. 12602

Contents

Illustrations

Safety

Personal safety cannot be overemphasized. Follow all safety precautions at all times. Use the safety practices outlined in IBM Form 124-0002, a pocket-sized card issued to all customer engineers.

For the IBM 729 Magnetic Tape Units, observe all safety rules when working on or near high-voltage areas.

Observe caution whenever IBM Tape Developer Medium and Tape Transport Cleaner, P/N 517960, is used; be familiar with *GP General/Safety CEM 25* or *729 Service Aid 162.*

DANGER

Never, under any circumstances, attempt to change tape unit power connections without first dropping the 208v supply voltage. Past failure to observe this rule has jeopardized CE's personal safety, and has caused short circuits that resulted in extensive damage to the Tape Adapter Unit, as well as to individual tape units. Play it safe—don't risk personal injury or unjustified system downtime—drop wall power before switching tape units.

IBM 729 II, IV, V, and VI Magnetic Tape Units

Increases in internal processing speeds have demanded faster input-output components for today's computers. Magnetic tape units meet this demand by combining economical data storage capacity with rapid data-handling rates, so that systems operations are not delayed waiting for input data read-in or for output storage space.

The IBM 729 II, IV, V, and VI NOR Magnetic Tape Units described in this manual are improved models of their 729 II and IV predecessors. The principal change is the replacement of relay circuitry with the new and reliable NOR-1 transistor logic. These tape units are fully compatible with corresponding 729 NORLAY and relay models. The 729 moves tape across the read-write head at a continual, constant speed whenever reading from or writing on tape, in contrast to incremental tape units, in which tape is brought to a complete halt between characters.

Serial Number Assignments

The various models of NOR, relay, and NORLAY tape units show no external differences. Serial numbers are assigned as follows:

New relay machines 729 II and V	70,000
New relay machines 729 IV and VI	40,000
Factory reconditioned relay machines 729 II and V	50,000
Factory reconditioned relay machines 729 IV and VI	80,000
*New NOR machines 729 II and V	30,000
*New NOR machines 729 IV and VI	90,000
New NORLAY machines 729 II and V	12,000
New NORLAY machines 729 IV and VI	61,000

NOTE: Asterisks denote machines described in this manual.

In field conversion of relay machines from 729 II and IV to V and VI, the tape unit retains its present serial number. Therefore, it is important to make specific reference to serial numbers during any correspondence or ordering of parts for a particular tape unit.

The tape units are controlled externally and have self-contained automatic and manual functions. The AC voltage is obtained externally; all dc voltages for relay and electronic circuits are developed within the tape unit.

Operating Features

Some of the operations under program control include:

Writing
Rewinding
Reading
Unloading
Backspacing (both records and files)

Operating features of the 729 II, IV, V, and VI are provided in the following table:

		729 II	729 IV	729 V	729 VI
Tape Speed (inches/sec)		75	112.5	75	112.5
Record Density (bits/inch)	Lo	200	200	200	200
	Med			556	556
	Hi	556	556	800	800
Character Time (μs per char) for Reading and Writing	Lo	67	44	67	44
	Med			24	16
	Hi	24	16	16	11
Character Rate per second	Lo	15,000	22,500	15,000	22,500
	Med			41,667	62,500
	Hi	41,667	62,500	60,000	90,000
Average Tape Access Time	(ms)	10.8	7.3	10.8	7.3

Machine Specifications

The following machine specifications are approximate and vary slightly depending on model of tape unit and engineering level.

Weight: 1,200 pounds
Dimensions: 34 inches long by 29 inches wide by 69 inches high
Vacuum: 729 II and V, 8 inches of water; 729 IV and VI, 16 inches of water
Voltage: 208v, three-phase, 60 cycles per second
Current per phase: 4.5 amperes
Input: 1.5 KVA

Tape Specifications

Mylar* and H-D Tape

Width: 0.498 inch
Total thickness: 0.0019 inch
Ferromagnetic material and binder: 0.00045 inch
Tensile strength (minimum): 12 pounds

The main physical difference between Mylar and H-D tape is the binder used to secure the ferromagnetic coating to the plastic base material. H-D tape has better wear characteristics and gives longer service than regular Mylar tape. H-D tape is gray-black; regular Mylar tape is brown.

Magnetic tape used in data processing is of the highest quality. Each reel of tape is tested by IBM to

*Trademark of E. I. duPont de Nemours & Co. (Inc.)

eliminate conditions that could lead to errors in either storing or reading information when using IBM magnetic tape equipment.

Humidity and Temperature Considerations

Proper tape storage is essential to satisfactory performance. If tape is stored where the relative humidity range is between 20 and 80 percent, the probability of read or write errors will be minimized. If tape is stored in an atmosphere outside these specifications, the probability of errors increases.

Temperature variations are secondary to humidity. If the tape is stored at about 70°F, no departure from the specified width should be observed.

Tape Capacity

Information may be written in any of seven tracks across the face of the tape. Each track is independent of every other track. See Figure 1.

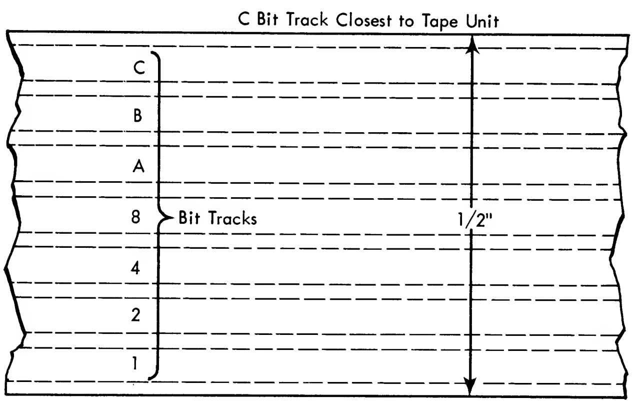


Figure 1. Bit Tracks on Tape

As tape is fed through the tape unit, the writing of characters (bits) is controlled by write pulses generated in the external control. Information is placed on tape in any desired bit configuration. Configuration and interpretation are determined by the external control.

Tape capacity is greatly affected by the inter-record gap (distance required to stop and start the tape). About 1/4 inch is required to stop tape; about 3/16 inch is required to get tape up to speed. (For accuracy, a write delay is built into the external control, so that total tape travel before writing is about 1/2 inch.) The combined distance required to stop and start writing is 3/4 inch. Through good programming, records may be combined to eliminate some inter-record gaps and conserve space on tape.

Storing Information

Magnetic Theory

A magnetic material can be fully or partially polarized when influenced by a magnetic field. A B-H curve, which can be plotted for every magnetic material, shows the flux density (B) that will result when the material is subjected to a magnetizing force (H).

Assume the magnetizing force is slowly increased in the positive direction to a maximum value H. The resultant flux density in the magnetic material increases rapidly at first, then slows down as a maximum flux value (B) is approached. Magnetizing force H may be expressed in oersteds in the cgs system or ampere turns per inch in the English system. Flux density B may be expressed in gausses (cgs) or lines per square inch (English) system, respectively.

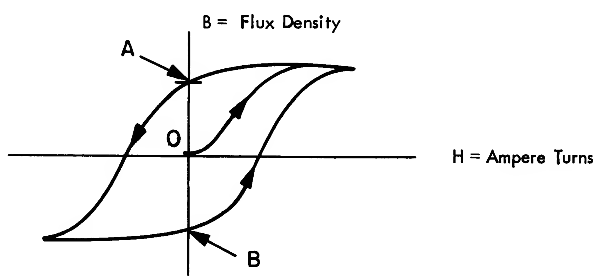


Figure 2. B-H Curve

The phenomenon of attaining a steady value of flux density is called saturation of the magnetic material. When the ampere-turns are slowly reduced, flux density also decreases, but at a different rate. This is the hysteresis effect. When the magnetizing force is again zero, the flux density is not equal to zero, but is equal to some positive value (point A). The amount of magnetic flux remaining (distance A-O) when H is equal to zero is the residual magnetism in the material.

If the ampere-turns are reversed by a reversal in current, flux density is increased in the negative direction until saturation again is reached. When current magnitude again is returned to zero, a negative resultant flux remains (point B). Using suitable circuit techniques, a flux pattern of either positive or negative polarity can be impressed on a magnetic material.

Figure 3 shows how information is stored on magnetic tape. The magnetic circuit consists of a laminated core, an air gap, a Mylar shim, and magnetic oxide on the tape. The core is MuMetal,† which has a high permeability and low retentivity. Permeability is the ability of a magnetic material to conduct lines of flux;

†Trademark of Allegheny Ludlum Steel Corporation

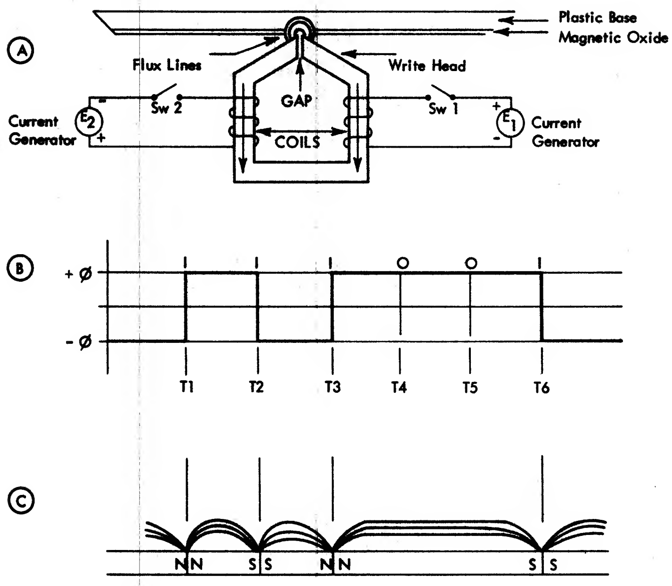


Figure 3. Method of Writing on Magnetic Tape (NRZI)

it is designated by the Greek letter Mu (μ) and is numerically equal to the ratio of the flux density to the magnetizing force ($\mu = B \div H$); the mu of air = 1. Retentivity is the capacity of a magnetic material to retain magnetism after the magnetizing force is removed. The oxide has a low permeability of about 7-9 and a high retentivity. The half-mil (0.0005-inch) write gap causes the magnetic lines of flux to diverge away from the head and into the magnetic oxide on the tape. The shim prevents loose oxide from filling the gap.

NRZI System (Nonreturn to Zero IBM)

Introduction

The NRZI system of recording binary information is one in which tape is continuously saturated in either the positive or negative direction. Within a given period of time, a change in saturation polarity is called a one, and no change is called a zero. The process of storing information is writing and the process of detecting stored information is reading.

Operation

When switch 1 (Figure 3A) is closed at time T1, current generator E1 causes current to flow through the coil; a flux path is set up as shown by the arrows. Because this flux path extends into the magnetic oxide on the tape, the oxide particles are magnetized in the direction of the flux path. If the tape is moving, all of the area passing over the write head is magnetized in the same direction.

If, at time T2, switch 2 is closed and switch 1 is open, current generator E2 causes current to flow through the opposite write coil. This causes the flux path to be reversed and the oxide particles to magnetize accordingly. Because the switching time is very short, the tape moves only a minute distance during the reversal. This process constitutes writing a one bit on the tape. If, at time T3, the flux in the head is again reversed, another binary one is written. If, at Time T4, no reversal is made, a binary zero is written. Thus, if a reversal in flux is made at any time, a binary one is written; if no reversal is made, a binary zero is written.

The magnetic material on the tape can be considered as a series of tiny bar magnets placed end to end. Where the change in flux occurs, there are like poles; where no change occurs, there appears to be one long magnet (Figure 3C).

Reading a binary one makes use of the principle that a voltage is induced in a coil whenever there is change of flux cutting the turns of the coil. (This can be stated in the fundamental equation: $e = -Nd\phi/dt$.) When a reversal of flux pattern is encountered as the tape is passed over the head, a voltage pulse is induced in the windings. This voltage is routed to amplifier circuits.

A binary one is sensed as a voltage pulse at the terminals of the coil. (This pulse is produced by a flux change in either direction.) The absence of a pulse (no change in flux) indicates a binary zero.

IBM 729 tape units employ a two-gap head that provides a means of reading a record during the same writing pass. This technique allows validity checking of the tape record as it is produced, and provides greater reliability in reading during subsequent operations. An erase head is also provided and used during a write operation to insure good erasure of old information before new information is written.

The advantages of the NRZI system are:

High Inherent Density: Binary ones can be written closer together than in a pulse system.

High Output When Reading: Maximum change of flux occurs from one saturation level to the other.

Simplified Erasing Technique: Erasing to saturation is simpler than erasing to zero flux. (Writing a new record erases the old record.)

Tape Handling

IBM magnetic tape is so durable that any limitation to successful use is almost always caused by physical damage, by the presence of cumulative wear products, or by contaminating foreign particles such as dust. Consequently, tape must be handled with care at all times to protect and extend its life. Also, maximum cleanliness must be preserved in and around tape units, tapes, reels, containers, and the general areas of use. Recommended conditions of temperature and relative humidity must be maintained.

Dust, dirt, or damage to the tape can reduce or prevent the necessary physical contact between the oxide surface of the tape and the read-write unit. Signal strength may be sharply reduced or information may be completely obliterated.

Because recorded information comes within 0.024 inch of the edge of the tape, tiny nicks and kinks caused by careless handling of tape or reel may seriously affect the quality of magnetic reading or recording. Damaged tapes are as ineffective as chipped or broken phonograph records.

As a result of the complete testing of each reel of magnetic tape throughout its length, no error-producing defects are present at the time of shipment to the customer. But after continued use, normal wear products may be generated and collect on the tape, foreign material may accumulate if proper handling procedures and precautions are not observed, or the tape may be inadvertently damaged.

Foreign material, wear products, a crease, or any condition that causes the tape to be lifted as little as 0.0005 inch from the read-write unit causes a signal loss of 60 percent. Lifting the tape away from the read-write unit 0.001 inch results in a signal loss of 87 percent, thus reducing the signal below the effective sensitivity of the read-write unit.

These errors are not confined only to the area directly under a particle. They also are produced in any adjacent area of tape that does not achieve physical contact as it travels over the read-write unit.

Satisfactory performance of IBM tape systems depends on magnetic tape that meets the specifications established by IBM. Tapes supplied by IBM meet these specifications.

Characteristics of magnetic tape made by other manufacturers may vary; tape units and tape control units cannot be adjusted to accept all of these different characteristics and still maintain the high level of performance expected from IBM equipment. The setting of each tape unit must be uniform to provide interchangeability of tapes between units within a system or between systems.

Adjust tape units and tape control units to obtain optimum performance from the customer's tapes. A 600-foot length of Mylar magnetic tape (P/N 461108) is available for use as a standard with which the CE may set read preamplifiers on all tape units. This tape is held to within ±1 percent of nominal signal level during manufacture as compared to ±5 percent for regular customer tapes. This exceptionally high quality tape reduces one of the possible variables present when attempting to set the peak-to-peak voltages accurately.

Any problems with the tape should be taken up with the supplier.

Physical Conditions

Several characteristic physical conditions are sometimes found during the use of magnetic tape. With a proper understanding of these conditions, the customer can avoid complications which otherwise might arise.

Irregular Winding

Normally, tape winds on the reel with some of the edges slightly protruding. These irregularities usually result from high-speed rewinding, which causes air to be trapped between adjacent layers of tape. Another contributing factor may be static electricity.

In themselves, slightly protruding edges do not interfere with the proper operation of tape. This condition, however, requires that proper care in handling tape be exercised by all operating personnel. The exposed tape edges can be badly damaged if they are squeezed through the reel openings or pinched in the edges of the reel.

Wavy Edge

One condition that can give magnetic tape the appearance of having a wavy edge is curvature. If a short length of tape is spread flat on a clean surface, its edge will not be perfectly straight but will form a slight arc. The arc should not exceed ⅜ inch in 36 inches of tape. Otherwise, the tape tends to turn in the vacuum columns. A nominal curvature is present to some degree in almost all tapes. Although it may produce a slight flutter in the vacuum columns, a curvature less than ⅜ inch in 36 inches of tape does not interfere with proper operation.

Another condition that can cause magnetic tape to exhibit a wavy edge results from edge damage. If the tape reel is improperly mounted, the edge of the tape will receive undue wear and become burred. This burr causes one edge of the tape to be slightly thicker than the other. When wound on a reel, the edge of the tape with the burr will wind to a larger diameter than the undamaged edge. After a period of time, the center of the tape will be permanently stretched. A tape in such condition will prove unpredictable and generally unsatisfactory. The read errors encountered are usually of the random, nonrepetitive type.

Cupped Tape

The outside layers of tape sometimes have a cupped appearance; that is, the oxide side of the tape may appear slightly concave.

Reel Warpage

Reels must be properly supported when not in use. The plastic container provided has been designed so that a reel is fully supported. A reel that is supported in any other manner may become warped.

One common reason why a reel wobbles or appears to be warped during use is that the reel may not be seated properly on the hub. The same effect is produced if the file protect ring is not inserted completely and the reel is, therefore, not fully seated. In either case, the reel behaves as if it is warped, and can produce damage to the edges of the tape.

Procedures and Precautions

The recommended conditions of temperature and relative humidity for operating IBM magnetic tape are as follows:

Recommended Operating Conditions

The recommended operating conditions for both Mylar and H-D tape are relative humidity of 20 to 80 percent and a temperature of 50 to 90 degrees F.

For extended storage of Mylar at humidities greater than 80 percent, tape reels must be hermetically sealed within moisture-proof plastic bags. This prevents the formation of mold growth and fungus.

Operating Procedures

Smoking should not be allowed in the machine room. Ashes can contaminate tape. Live ashes can produce permanent damage if they touch the surface of the tape.

Tapes that contain useful information must not be exposed to magnetic fields with an intensity greater than 50 oersteds.

During loading, the tape should be taken directly from the container and mounted in the tape unit. After unloading, the tape should immediately be replaced in its container.

Extreme care must be used while removing the file protect ring. Under no circumstances should the ring be removed while the tape is loaded in the columns.

When being loaded, the reels should be pushed firmly against the stop on the mounting hub to insure good alignment.

Special precautions should always be taken to make sure that the hub has been tightened during loading.

To wind the take-up reel to the load point, rotate the reel with the finger in the recessed finger hold on its surface. Rotating the reel with the finger in the cut-out will nick or curl the guiding edge of the tape.

While the tape is on the machine, the container should be closed and put in some location where it is not exposed to dust or dirt.

The tape unit should be allowed to complete the unload sequence before the door is opened.

The reels should be handled near the hub whenever possible. If difficulty is encountered while removing the reel, the bond between the reel and the hub can be broken by placing the palms of the hands along the edges of the reel and rotating it. The reel should never be rocked by grasping the outer edge. If a tape break occurs, the reel should be divided into two smaller reels. Splicing is not recommended. If it is necessary to make a temporary splice to recover information, special low-cold-flow splicing tape should be used.

Be careful when placing reflective strips on tapes. Trouble may result if the tape is soiled or damaged in the process.

General Handling Procedures

Do not use the top of a tape unit as a working area. Placing material on top of the unit exposes it to heat and dust from the blowers. It may also interfere with cooling of the tape unit.

A reel card holder is provided for identifying tape reels. If adhesive stickers are used, make sure they do not leave a residue. Use stickers that can be easily applied and removed. Never alter labels with an eraser.

A loose end of tape should never be allowed to trail on the floor.

When necessary to clean tape, gently wipe the tape with a clean, lint-free cloth moistened with tape transport cleaner (Mylar) or water (Heavy Duty). Extended exposure of tape to the solvent should be avoided; damage to the tape can result.

Periodically inspect the plastic tape reel containers for accumulated dust. Containers can be cleaned with a vacuum cleaner or by washing with a regular household detergent.

Pinching of the reels and any contact with the exposed edges of the tape should be carefully avoided.

Dropping a reel can easily damage both reel and tape and make their subsequent use unsatisfactory.

Reels of tape, whether in or out of a container, should never be thrown or carelessly handled.

Storage Procedures

The tape must be supported at the hub and kept in its container to protect it from dust when not in use.

Tapes should be stored in some type of cabinet elevated from the floor and away from sources of paper or card dust. This should minimize the transfer of dust from the outside of the container to the reel during loading or unloading operations.

Before reels are stored, sponge rubber grommets should always be placed on the reels to prevent the free end of the tape from unwinding in the container.

If shipping of tape reels is necessary, the tape and reel should be packed in the plastic container provided for this use. The container should be hermetically sealed in a plastic bag. Additional support should be obtained by packing in individual stiff cardboard shipping boxes.

Tape Developing

Both heavy duty and Mylar tape can be developed with the bit viewer, P/N 461180. To use the bit viewer, release an extra loop of tape from a reel including the area to be developed. Remove the bit viewer from the leather case and hold the tape between the white plastic card and the bit viewer. Shake the bit viewer so that the liquid with the iron filings in suspension passes over the area of tape to be developed. View the developed area of interest.

An alternative method for developing tape is:

1. Dissolve a tablet of iron filings, P/N 460997, in a jar of tape developer (Mylar) or water (H-D).
2. Keeping the iron filings in suspension in the solution, form a loop of tape including the area to be developed, and work the tape back and forth in the jar.
3. Remove the tape from the jar and let it dry.
4. The tape can be viewed by taking the bits (iron filings) from the tape with a transparent tape or by placing white paper beneath the developed area of the tape.
5. Clean the tape carefully before returning it to use.

CAUTION

Tape developer ruins Heavy Duty tape. Make sure that no trace of the developer ever stays on any of the transport area.

Operator's Panel

The operating keys and lights (Figure 4) are located in the front upper section of the tape unit.

Keys and Lights

Select Switch: This is a rotary switch located at the left of the group. It is used to set the tape unit to one of ten addresses associated with an external control. The select switch is mounted horizontally and is operated by a large diameter knurled disk. Only a small section of the disk protrudes from the panel. The selected address is indicated on an illuminated translucent band which rotates with the knurled disk.

Select Light: The select light is on when the tape unit is selected by an external source, or when switched off-line by the rear CE panel switch.

Start Key: Pressing the start key places tape unit under computer control and in ready status if the tape unit is fully loaded and mechanically ready. The start key may be pressed during a load or rewind operation, but the tape unit will not be in the ready status until conditions are satisfied.

Reset Key: This key removes the tape unit from computer control and turns off the ready light. In addition, it returns a high-speed rewind to low speed. It completely stops a low-speed rewind. The reset key also suspends either loading or unloading of tape in the columns.

Ready Light: This light is on if the tape unit is in ready status. Manual control is indicated when the ready light is off, if the tape unit is not rewinding or loading.

Load-Rewind Key: Pressing this key starts two operations: loading tape and searching for the load point. If tape has been unloaded manually in the high-speed rewind area of the tape (more than one-half inch of tape on machine reel), pressing this key executes a high-speed rewind before the load and search operations take place. This key is inoperative unless the tape unit is under manual control.

DANGER

Reels can come apart during high-speed rewind. Always keep the sliding glass panel closed during high-speed rewind.

Unload Key: Pressing this key causes tape to be pulled out of the columns and the upper head assembly to rise, regardless of the distribution of tape on the two reels. If the tape is not at load point when the operator wishes to change tape, a load-rewind operation should be completed before the unload operation is started. This key is inoperative unless the tape unit is under manual control.

Change Density Key: Pressing this key changes the present density status of the tape drive (high to low, or low to high). This key is inoperative unless the tape unit is in manual control (not "ready").

Density Lights: These lights indicate the density status of the machine.

Tape Indicator Light: This light is lit when the tape indicator is turned on by sensing the end-of-reel reflective spot on tape while writing. It may also be turned on or off under external control. Unloading also resets the indicator.

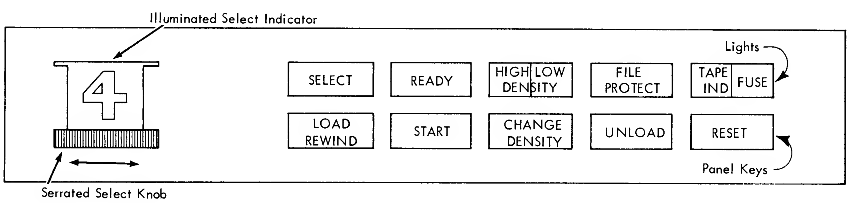


Figure 4. Operator's Panel

File Protection Light: This light is conditioned to turn off by mounting an unprotected reel on the unit (ring in file reel). It is on (1) if no file reel is mounted, (2) if a file reel with no ring is mounted, (3) during a load or rewind operation.

Fuse Indicator Light: This light is on when any circuit protector except AC circuit protector 1, 2, or 3 or DC circuit protector 1 is tripped.

Operator's Panel Signal Lamps

Use 55B lamps, P/N 344987, as replacements in the operator's panel. Do not use 55C lamps, P/N 308346, because they have a shorter life than the 55B type. (A 12v lamp, P/N 589102, is used in the file protect circuit). The type number and suffix are stamped on the base of the lamp.

Removal

To remove panel lamps, use a laminar bus extraction tool, P/N 461074.

CE Test Panel

Each 729 NOR Magnetic Tape Unit is equipped with the necessary controls to allow on-line checking of all essential operations and functions. Two panels provide the lights, switches, and test points. All necessary circuitry either exists in the machine or is provided on one additional double SMS card. One of these AWA-cards, P/N 373305, is supplied for each installation and is inserted by the customer engineer at checkout time.

One multiwafer selector switch makes it possible to logically remove the tape unit from the system. This provides a means of easily removing a faulty unit from the system and allows customer engineering on-line testing without interfering with the customer's operation.

Rear CE Panel (Figures 5, 6, and 7)

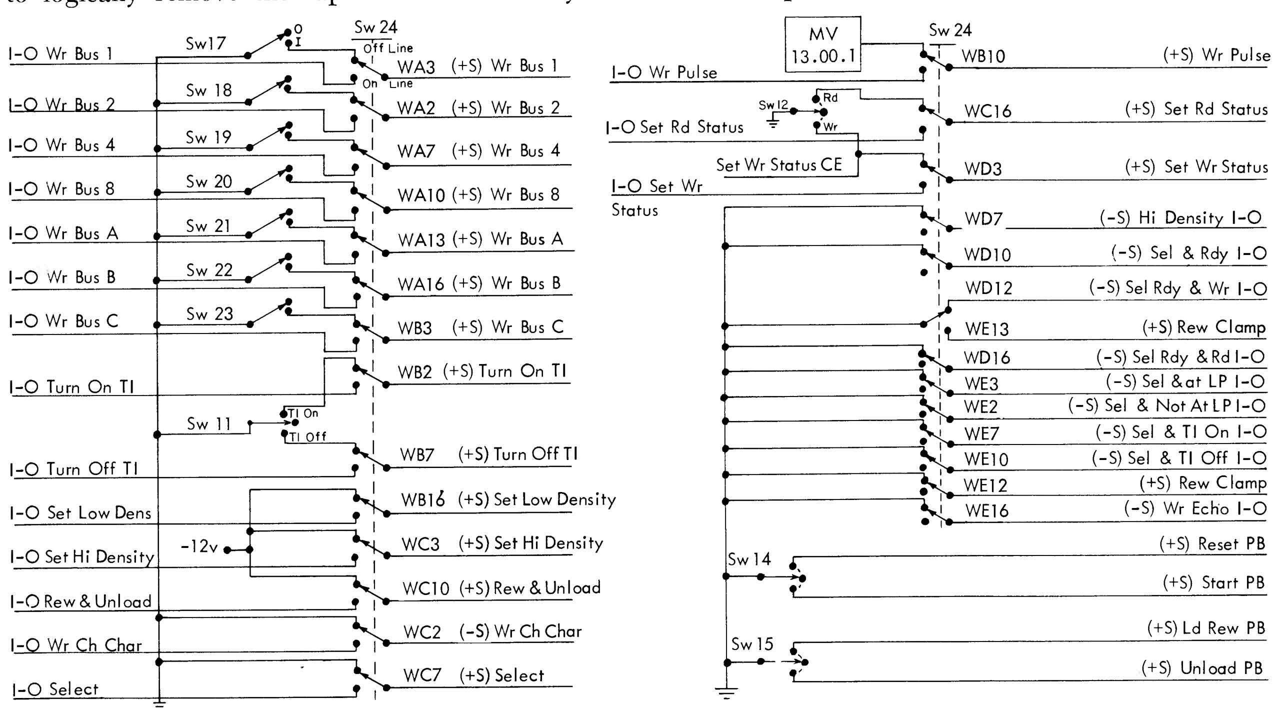
Switches

On Line/Off Line Switch (Sw 24): This multiwafer switch logically disconnects the tape unit from the system with no need for cable removal, power transfers, or customer interruption. Its effect on the tape unit is to: (1) Block all necessary input signals at the I-O cable, (2) hold all I-O output levels at +S (ground) to prevent introducing signals onto the main I-O bus, and (3) activate the keys and switches available for CE use (see Figure 5).

Start-Reset (Sw 14): This three-position spring-returned switch parallels the switches on the operator's panel and either brings up or drops ready status.

Load-Unload (Sw 15): This three-position spring-returned switch parallels the operator's panel switches to cause loading or unloading if the tape unit is not in ready status.

Set Read/Set Write (Sw 12): This three-position switch allows the tape unit to be set to either read or write status. It is normally used with the backward-auto-manual (Sw 13) and start stop-manual-suppress GO (Sw 9) switches to accomplish read or write cycling of the tape.



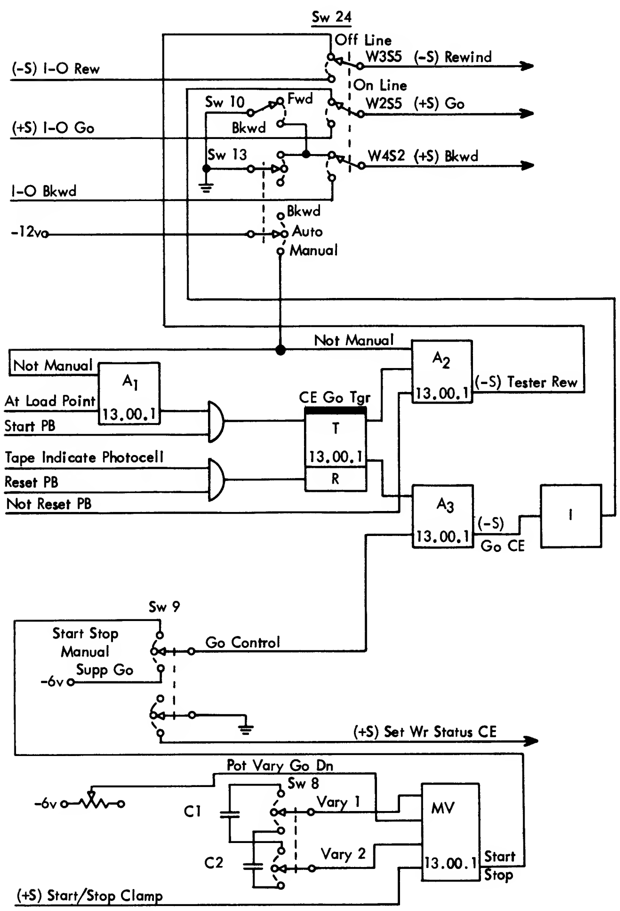
• Figure 5. CE Panel Switches

Turn TI On/Turn TI Off (Sw 11): This three-position switch turns the tape indicator on or off if the tape unit is in ready status.

Manual-Auto-Backward (Sw 13): See Figure 6.

MANUAL—with switch 9 in either the START-STOP or MANUAL position, reading or writing is under control of the start and reset keys. Pressing the start key causes the operation to continue until either the reset key is pressed or the end-of-tape reflective spot is sensed. At this point, the operation ceases. Note that the ungated output of the TI photocell is used to reset the CE GO trigger. This pulse is available during a read or a write operation.

AUTO—This operation is similar to the MANUAL position except that cycling automatically occurs at end of tape (A2) and at load point (A1). Sensing the output of the TI photocell turns off the CE GO trigger and initiates an automatic rewind to load point. Load point sets the CE GO trigger and again restarts the cycle.



• Figure 6. CE Tester Control

Final stopping is under control of the reset key. To maintain a write cycling operation, it is necessary to leave switch 12 at SET WRITE. The first rewind initiated by the TI photocell causes a reset of the write trigger until load point is reached. If switch 12 were returned to its neutral position, a read cycle operation would occur after the first pass of tape.

BACKWARD—This position of the switch causes tape to backspace under either manual or variable start-stop GO control until load point is reached. Load point circuitry prevents any further motion beyond this point and there is no cycling.

Bit Switches (Sw 17-23): These switches control the writing of either ones or zeros in their respective tape tracks.

Front CE Panel (Figure 8)

Switches

Backward/Forward (Sw 10): This switch allows control of forward or backward motion from the front CE panel and is used with the backward-auto-manual and start stop-manual-suppress GO switches.

Start Stop-Manual-Suppress GO (Sw 9):

START-STOP—This setting allows GO to rise and fall under control of a multivibrator and its associated potentiometer and the high-low-medium frequency switch (Sw 8). Once the start key is pressed and the CE GO trigger is turned on, the tape unit reads or writes under variable start-stop control.

MANUAL—In this position the multivibrator is removed from the circuit and "GO control" is allowed to float into A3 (Figure 6). GO is now under control of the start and reset keys.

SUPPRESS GO—This position prevents GO from becoming active by holding the lower leg of A3 to −6 volts. Suppress GO also automatically sets write status because this setting is normally used to check H-shield feedthrough and prolay adjustments.

High-Low-Medium Frequency (Sw 8): Start-stop time of the tape unit can be varied by this switch and associated potentiometers. The approximate range for each setting is:

Low—1-15 milliseconds
Medium—15-175 milliseconds
High—1-5 seconds

By synchronizing on the "GO" line and observing the preamplifier output, start-stop times can be displayed for either forward or backward operations.

Lights

1-C Bit indicates the status of its associated write trigger.

Write Status indicates either write status (on) or read status (off).

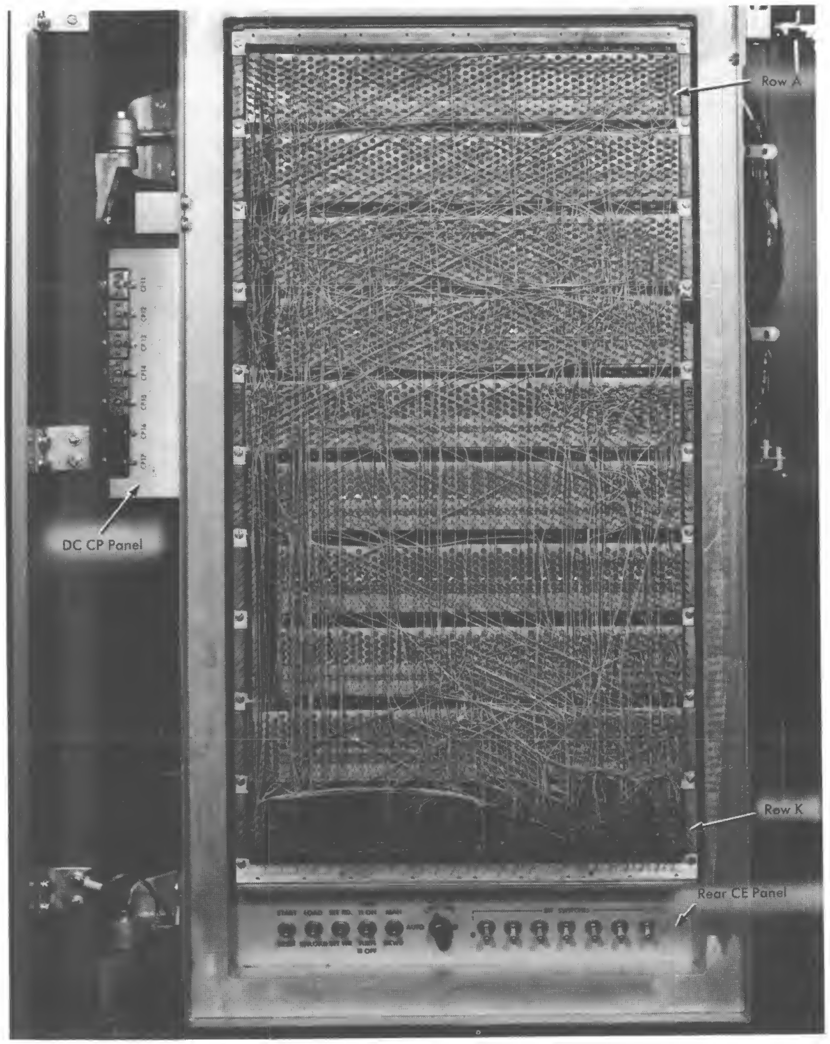
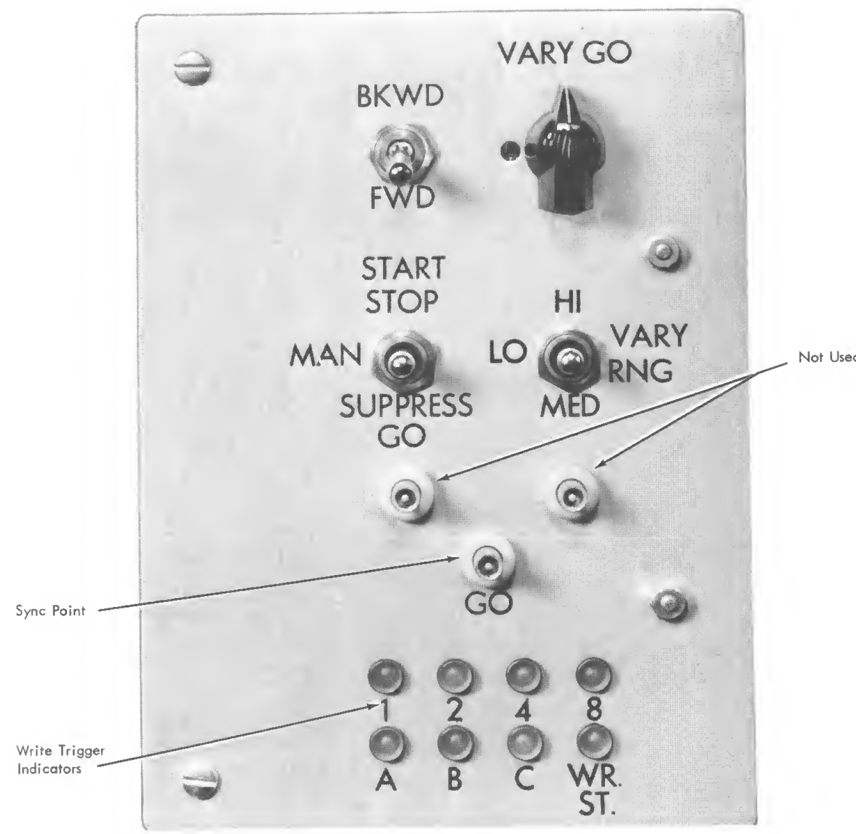


Figure 7. Rear Logic Panel



• Figure 8. Front CE Panel

Sync Points

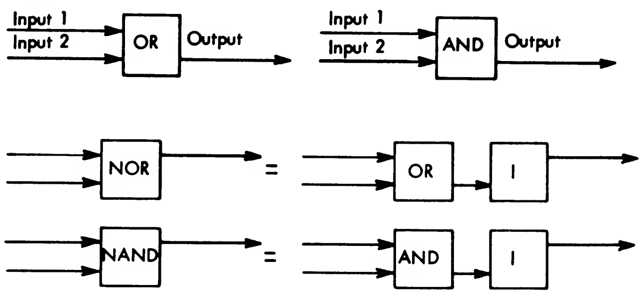
1 and C Bits are not wired.

GO indicates the output of internal GO.

NOR Circuitry

The 729 II, IV, V, and VI Magnetic Tape Units described in this manual utilize NOR-1 circuitry. NOR logic is a collection of NOR and NAND, and implies NOT OR and NOT AND.

Conventional OR and AND circuits are shown in Figure 9. The output of the OR block is positive if either or both of the inputs are positive and is negative only when both inputs are negative. The AND output is positive only when all inputs are positive; any input going negative drops the output.



• Figure 9. Conventional OR/AND Circuits and NOR Circuit Equivalents

NOR and NAND have a similar meaning, except that they produce the additional effect of an inverter immediately following the circuit. A NOR block, then, is the equivalent of an OR block followed by an inverter. A NAND block is equivalent to an AND block followed by an inverter.

In this manual, NOR blocks always show as −O; NAND blocks show as +A. In each case, the effect of an inverter is present. In some cases, to show simplified or second level system circuits, positive logic may be shown. Here, the signs are omitted; an OR circuit is shown as an O, an AND is shown as an A, and there is no implied inversion.

In the logic design of computers, only three basic elements are required to meet any desired set of conditions. These three basic blocks are OR's, AND's, and inverters. Other elements—triggers, amplifiers, drivers, and so on—are also used to make the machine fully operational, but the controlling logic only requires the three basic functions.

With NOR circuitry, the combination of two of these elements has been realized: OR and inversion, and AND and inversion. Figure 10 shows that either a one-legged NOR or a one-legged NAND circuit is equivalent to an inverter.

The NOR and NAND circuit blocks are identical electronic circuits (Figure 11). Thus, a two-legged logic block could be either a two-legged NOR (−O) or a two-legged NAND (+A) depending on the particular logic demand of the circuit. This means that all logic design within the 729 NOR tape unit can be accomplished with one type of circuit or SMS card, making possible mass production of these parts and correspondingly fewer SMS card part numbers per machine.

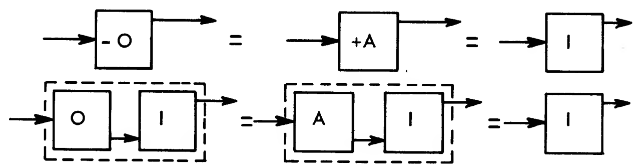


Figure 10. One-Legged NOR Inverter

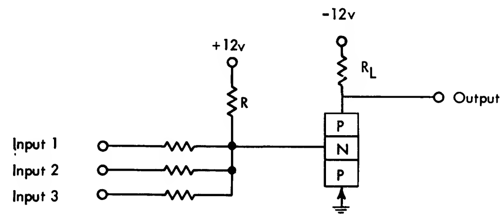


Figure 11. Three-Legged NOR Circuit

Also, the NOR circuitry achieves both voltage and current gain; a signal can travel through an unlimited number of stages without degeneration.

Circuit Description

The basic PNP NOR circuit is shown in Figure 11 and is a saturating voltage mode circuit. The input and output levels are either at −12 (−S) or ground (+S).

The transistor is turned on (saturated) whenever any one of the three inputs is at a down level. For the transistor to be cut off, all inputs must be up to ground level (0 volt). The three input resistors provide the logic function. The transistor inverts the base input signal, establishes an ON level (level setting), and supplies the necessary powering.

The maximum number of inputs is three. The maximum number of outputs depends on the type of loading and usually is either three or four. The main requirement is that the down (−S) level should not become more positive than −5.56 volts.

Second Level Representations

To eliminate unnecessary logic blocks from second level representations wherever possible, logic blocks are shown with an in-phase and an out-of-phase output (Figure 12). This phasing convention applies regardless of block type. NOR logic, however, has only out-of-phase outputs.

Some circuits perform more than one function; therefore, two logic blocks are sometimes necessary to show what happens.

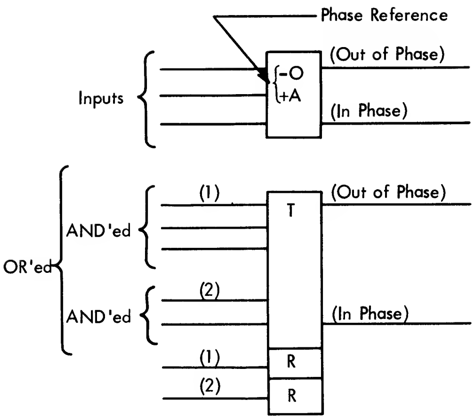


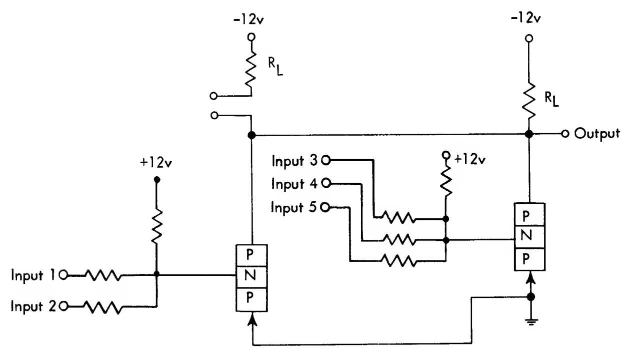
Figure 12. Circuit Conventions

Trigger blocks are sometimes shown with two resets or sets. Figure 12 shows the convention for this type block. The upper reset would be operative for the upper AND'ed conditions; the lower, for the lower set of AND'ed conditions. A trigger cannot set with one of its resets conditioned.

SMS Circuit Cards

NOR-1 circuits use either two or three inputs; therefore, two SMS cards are provided. The CD card (Figure 14) contains three 3-input circuits. The MX card (Figure 15) contains four 2-input circuits.

At times it is necessary to have more than three inputs to a NOR circuit block. This is accomplished by making one of the circuits an extender. On both the CD and MX cards, one circuit has a break in the load circuit. By connecting the output (collector) of this transistor to the load of one of the other circuit transistors so that there is a common load, it is possible to make a five-legged block (Figure 13).



• Figure 13. NOR Extender Circuit

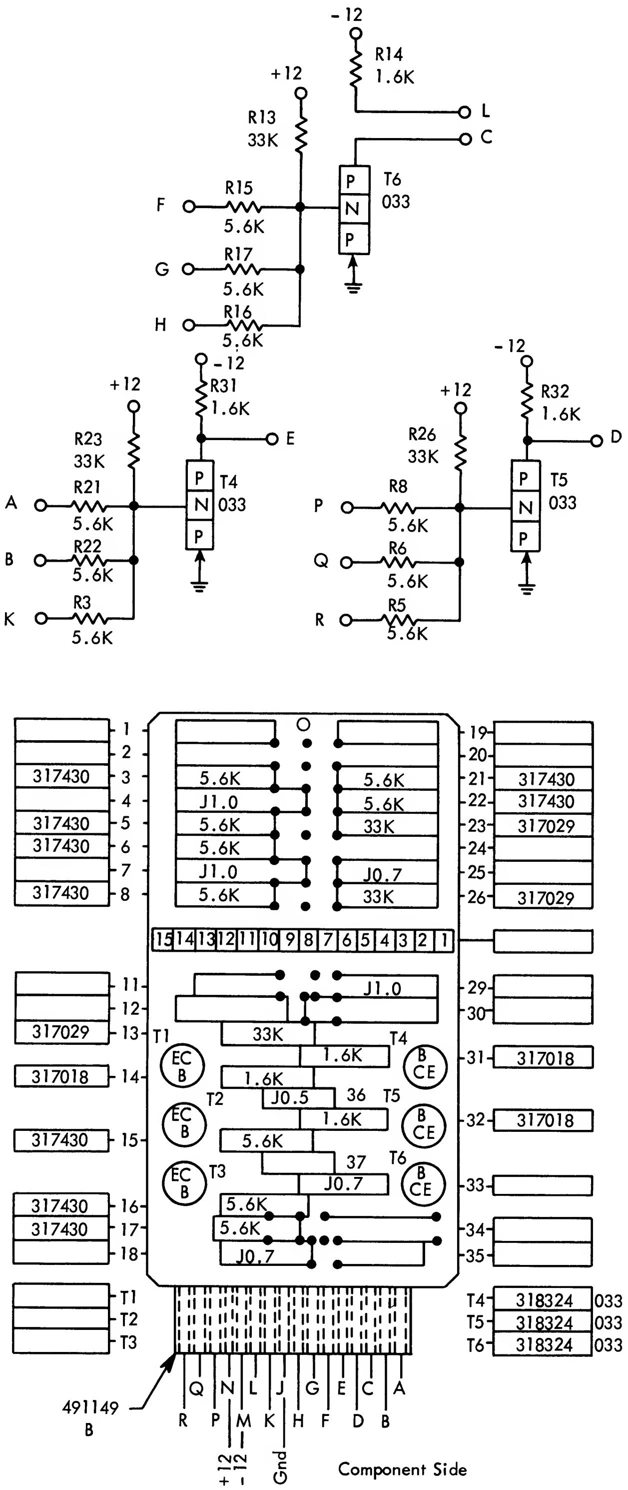


Figure 14. CD - - Card Circuitry

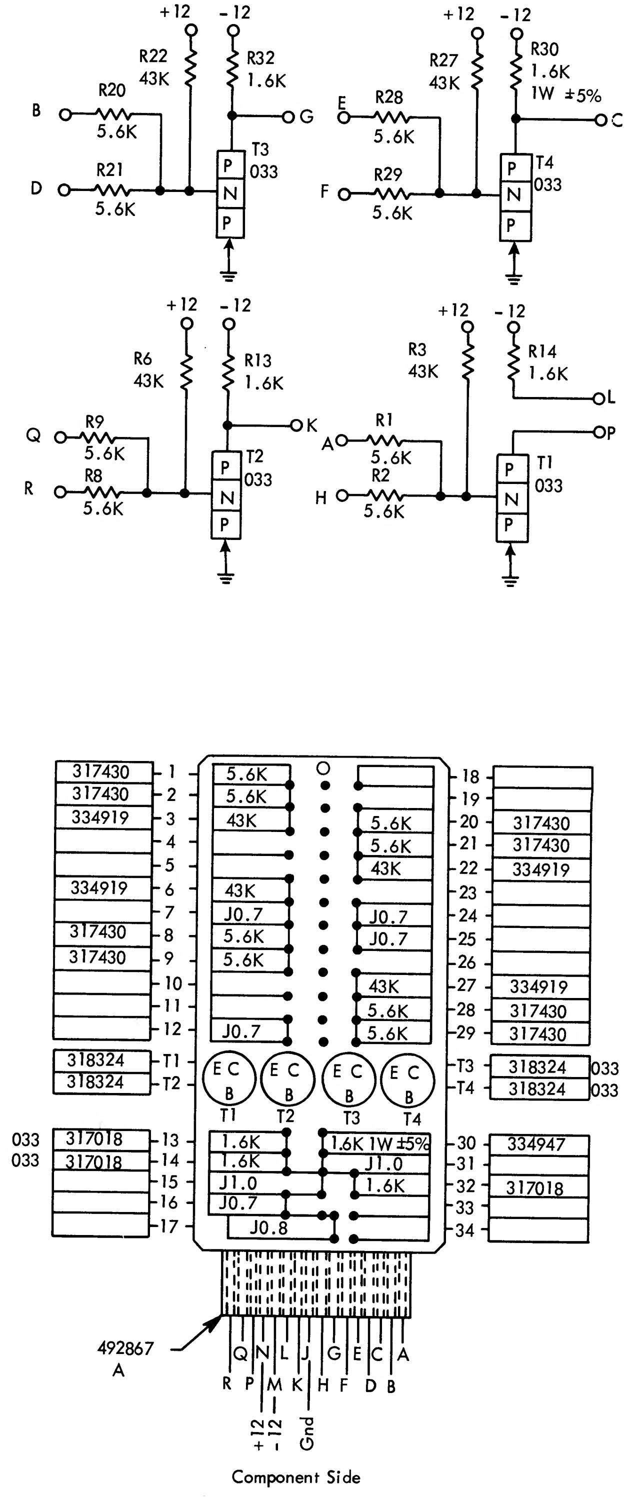


Figure 15. MX - - Card Circuitry

Approach to Scheduled Maintenance

Scheduled maintenance's prime objective is achieving maximum customer machine availability. Unless scheduled maintenance reduces total downtime, it is useless and unnecessary.

Visual Inspection

Make visual inspection a part of every scheduled maintenance operation. Always be alert for evidence of corrosion, dirt, wear, cracks, binds, burnt contacts, and loose connections and hardware; correct these conditions before they result in machine downtime.

Electronic Circuits

Run diagnostic programs and perform pulse-checking routines as scheduled to locate and diagnose existing and potential troubles.

Mechanical Units

Clean, lubricate, and inspect electromechanical units as scheduled. Do not do more than recommended scheduled maintenance on a unit that is operating properly.

Scheduled Maintenance Routine Chart

Recommended punched-card maintenance schedules are furnished by local customer engineering offices. Refer to the Scheduled Maintenance Routine Chart when performing operations listed on these cards. Consult the listed manual pages for detailed explanation of unfamiliar routines.

Tape Transport Cleaning

Clean the tape transport mechanism at least once every eight hours, or after ten full-reel passes of tape, whichever occurs first. Materials required for cleaning the transport are available in a tape cleaning kit, P/N 352465. Individual item part numbers are listed in IBM 729 Service Aid 260.

DANGER

Exercise caution whenever using the tape transport cleaner. Be familiar with *GP General/Safety CEM 25* or *729 Service Aid 162*. Avoid prolonged or repeated contact of tape transport cleaner with the user's skin.

Cleaning Hints:

1. Use a minimum amount of cleaner when cleaning the tape transport area. Cloths and pads should be moistened, not wet.
2. Do not, under any circumstances, use any metal instrument to clean the vacuum columns or rewind idlers. The SMS Back Panel Probe, P/N 461262, makes an excellent tool for removing oxide clumps. File the flat end to a "chisel" point, which, being plastic, can be used to remove oxide without risk of damaging metal transport surfaces.
3. Inspect to make sure that no loose fibers from the cleaning cloth or applicator remain in the transport area after cleaning.

Tape Transport Cleaning Chart

Refer to the Tape Transport Cleaning Chart when performing daily and weekly cleaning operations.

SCHEDULED MAINTENANCE ROUTINE CHART

ROUTINE	FREQ WKS	OPERATION	OBSERVE
0	Note 1	Scope start-stop time	Waveforms and timings
		Lubricate armature and arm pivot shafts with IBM 6 Lubricate nylon idler pivot shaft with IBM 4	Replace defective parts. Do no lubricate prolay dust seals
1	13	Filters - Visually check filters. Replace as required	Blower motors for proper operation
		Use CE panel to move tape continuously	Tape operation in vacuum columns (sluggish operation may indicate powder leakage from magnetic clutch). Check tape break circuit and high-speed rewind If clutches are sluggish, check response with DC tachometer as described under reel clutch drive adjustment
2		Clean base as required	Capstan motors and high-speed rewind idlers for binds. Vacuum switches for broken or cracked straps and pitted points. Tape cleaner blade for damage. Belts for wear and tension. Capstan motor mounts and front bearing for play
3		Check H-shield for binds or cocking	Position with respect to gaps
		Check magnetic clutch brushes	Wear and arcing
		Check for write feed-through	With no tape movement (suppress go) write 1's in all tracks. At the read bus there must be less than 0.40 peak-to-peak voltage
		Check erase head operation	Less than 0.4 volts peak to peak should remain after erasing
		Check read-write skew	Readjust skew if any track is out by more than .25 microsecond
		Check write asymmetry (729 V and VI)	Coincidence of outputs from skew register A in TAU while writing 1's
9		Misc lubrication IBM 6 - Capstan shaft and motor bearings, head assembly felt oil pads and pivot points IBM 17 - Vacuum column cover latches	No lubricant should be used in the vacuum column area
8	26	Power Supply - Check voltage levels and ripple at specified points	Voltage — Ripple — Test Point -6 ± 0.24 — 0.48 — A3K01M +6 ± 0.24 — 0.48 — A3K01H -7.5 ± 0.75 — 3.30 — A3K01P -12 ± 0.48 — 0.96 — A3K01G +12 ± 0.48 — 0.96 — A3K01A

Note 1: Frequency of prolay maintenance should be determined by gap diagnostics and/or customer performance.

TAPE TRANSPORT CLEANING CHART			
FREQUENCY	TO CLEAN	USE	NOTE
D	Split guides	Small brush or typewriter brush	Remove accumulated oxide: On surface of guides: Between ceramic elements. Inspect with dental mirror
D	H-Shield	Lint-free cloth or pad Tape transport cleaner	
D	Tape cleaner blade	Small brush or typewriter brush	Rub lightly
D	Tape cleaner block	Cotton-tipped swab	Clean out aperture
D	Rewind idlers	Lint-free cloth or pad Tape transport cleaner	Use wooden toothpick to remove stubborn oxide clumps.
D	Drive capstans	Clean lint-free cloth (Wrap cloth around typewriter brush handle)	Scrub vigorously while rotating drive capstans by hand. Note: Do not clean capstans under power.
D	Prolay idlers	Lint-free cloth or pad Tape transport cleaner	Rub idler in direction parallel to circumference.
D	Stop Capstans	Lint-free cloth or pad Tape transport cleaner	Clean stop capstan surface where prolay idler contacts it.
D	Read-Write head	Lint-free cloth or pad Tape transport cleaner	Cloth pad to be moistened only. Do not soak.
W	Vacuum columns	Lint-free cloth Tape transport cleaner	Use wooden toothpick or SMS back panel probe to remove oxide clumps. Note: Do not use any metal instrument to clean vacuum columns.

Freq:
"D" = Daily, or every ten full-reel passes of tape
"W" = Weekly

Component Locations (Figures 16, 17, 18, 19, 20)

The front of the tape unit (Figure 16) contains the door assembly, customer controls and indicators, CE panel and adjustments, access to the preamplifier circuit panel, and tape transport and column assembly.

The transport assembly contains the tape reels, columns, read-write head, prolays, and associated parts. It is secured to the welded frame unit at three points by transport shock mounts. In the upper section, behind the front plate, are the reel and capstan drive motors, head and tape take-up motors, high-speed rewind and fan motors, reel clutches, file protect relays, and associated mechanical couplings and wiring.

The lower center area contains the power supply assembly, vacuum motors, and preamplifier circuit housing.

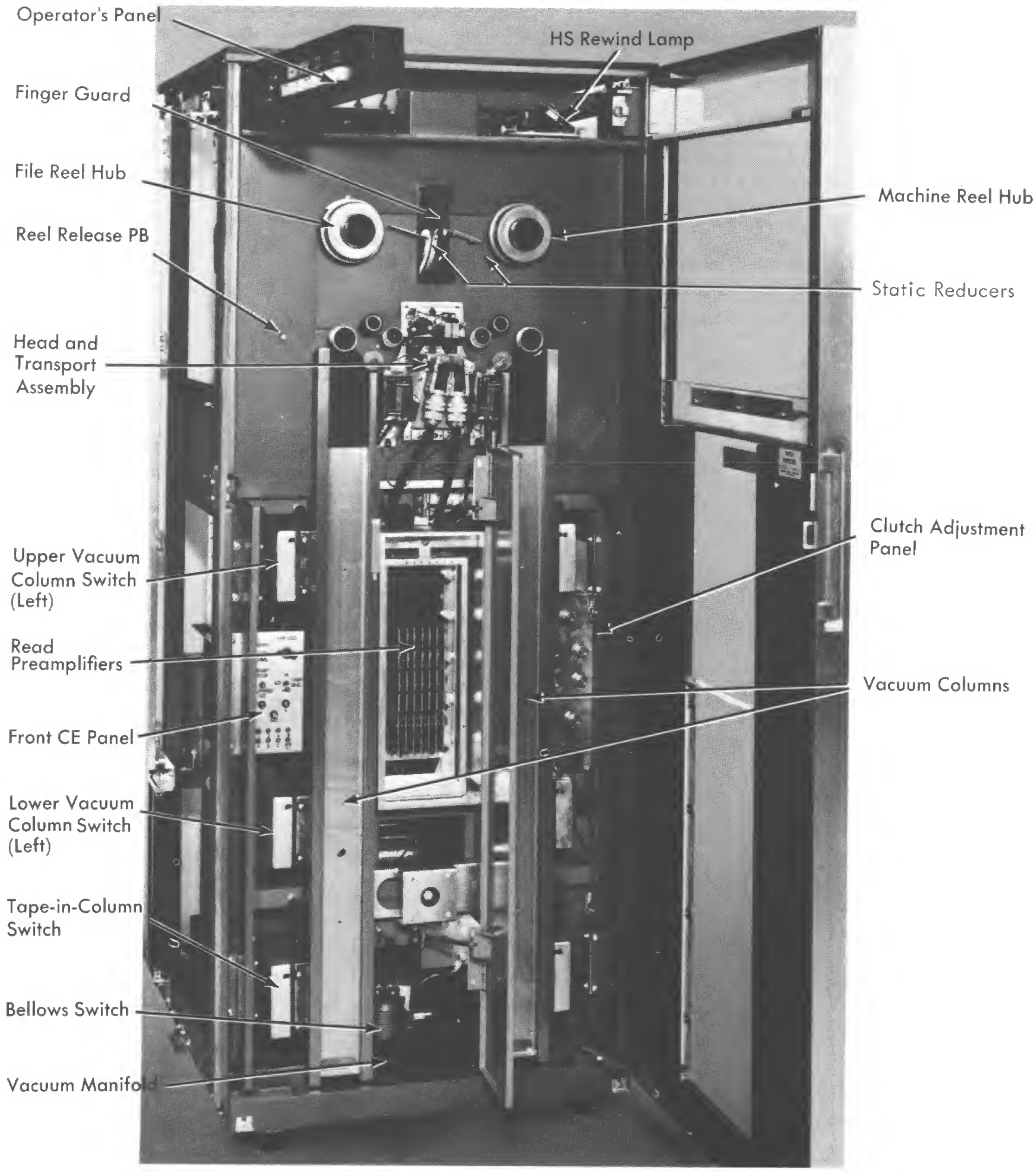
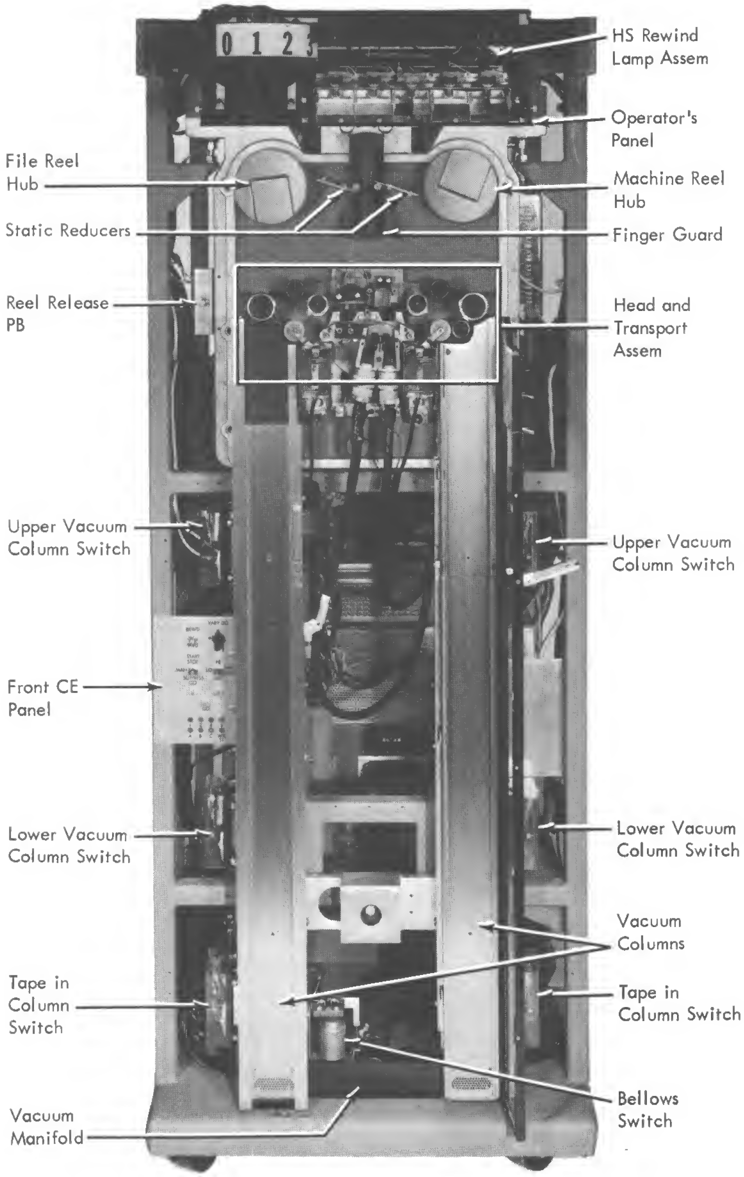


Figure 16A. Tape Unit, Front



• Figure 16B. Tape Unit, Front, Machines After EC 252719

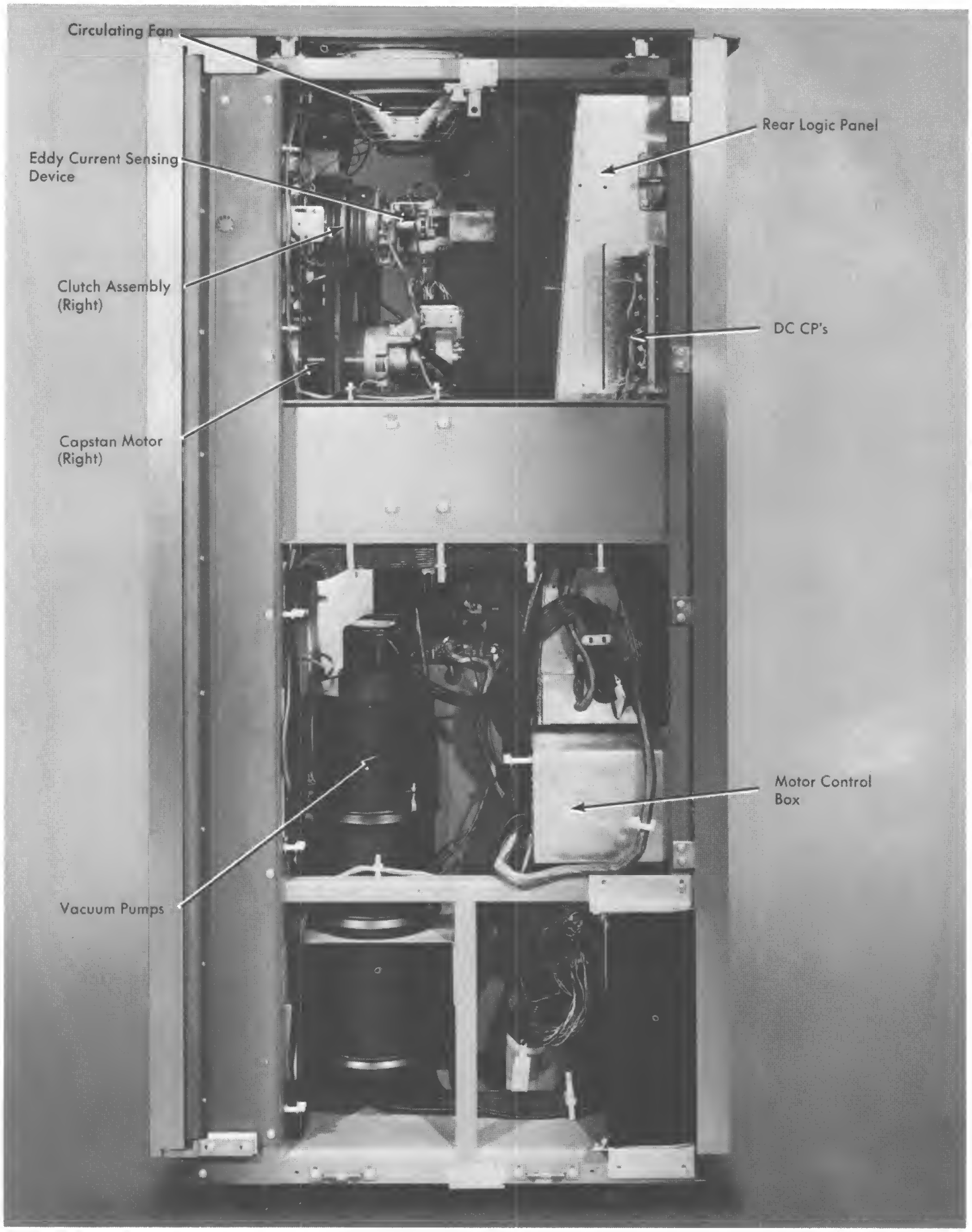
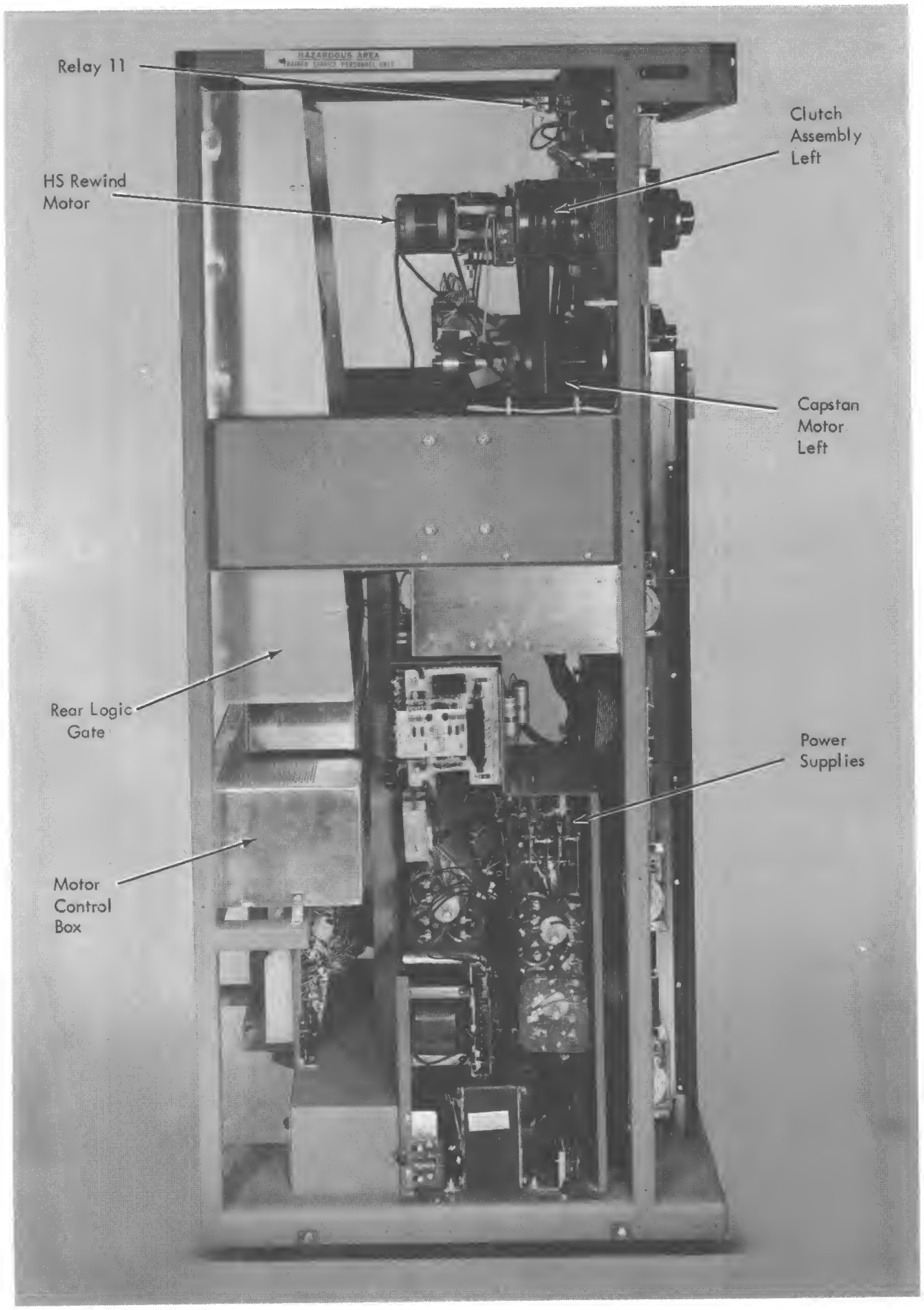


Figure 17. Tape Unit, Right Side



• Figure 18. Tape Unit, Left Side

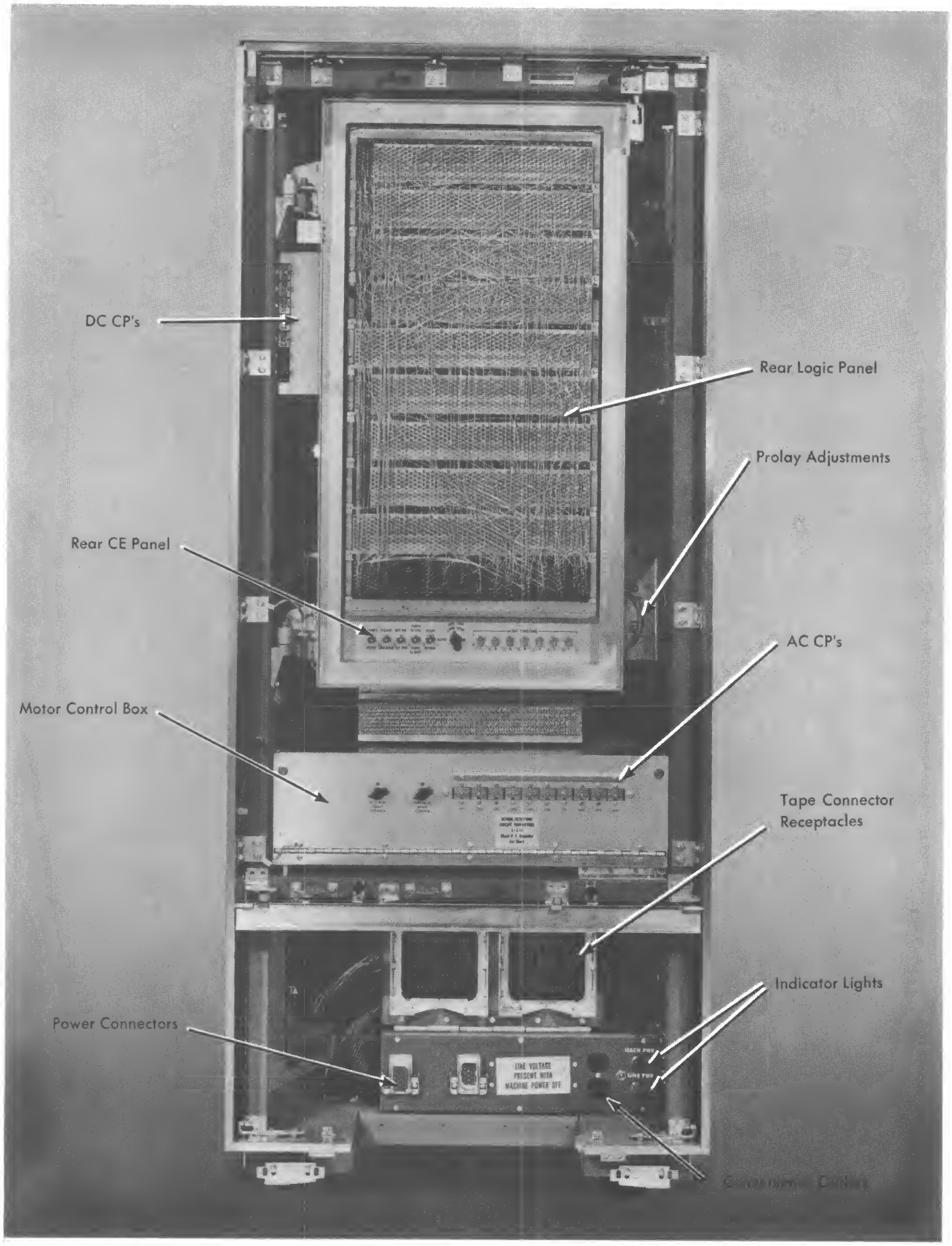


Figure 19. Tape Unit, Rear

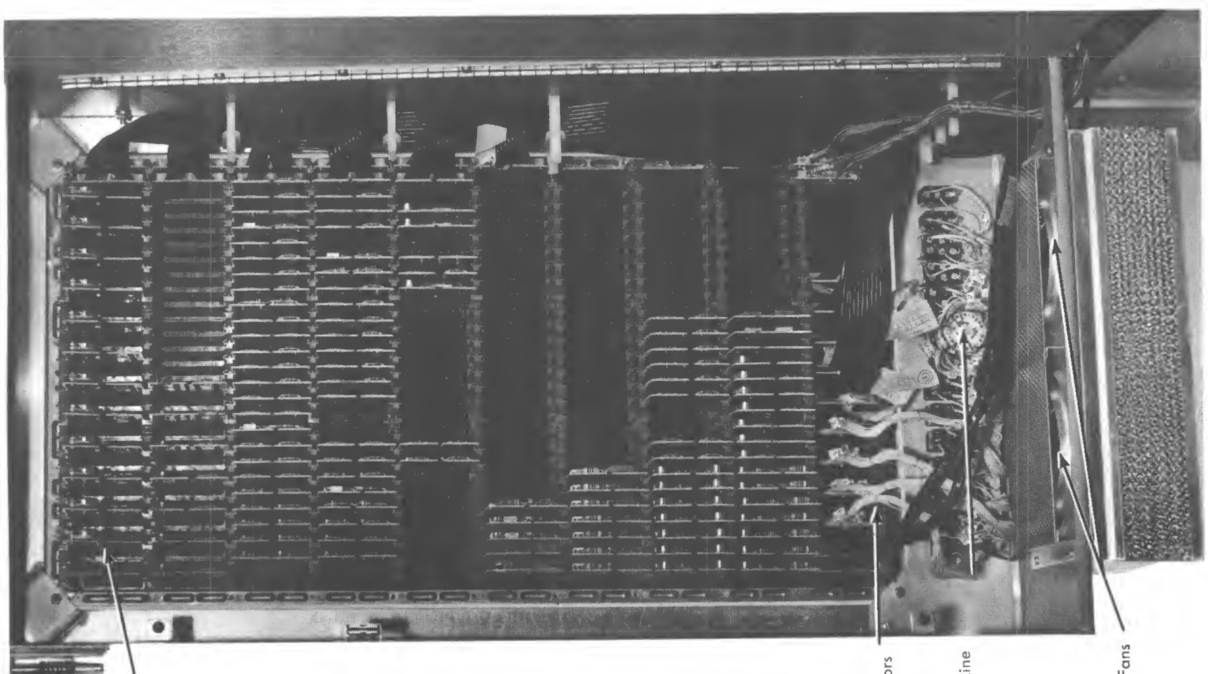
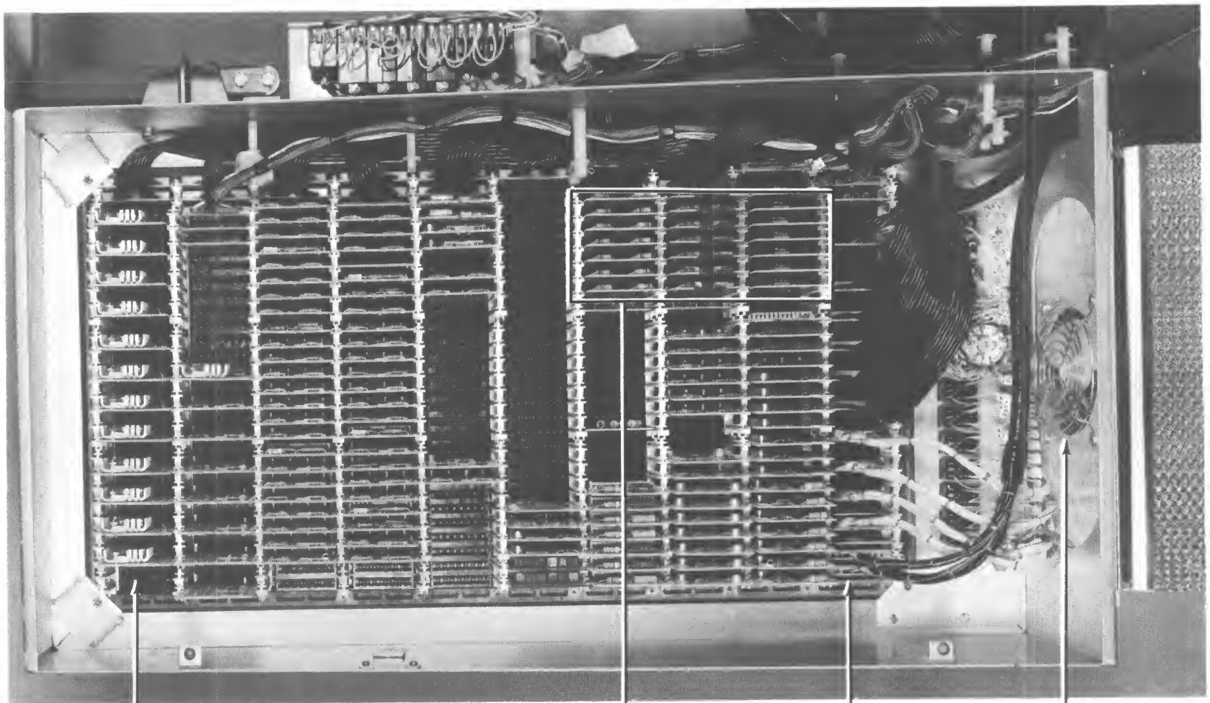


Figure 20A. Rear Logic Panel (Card Side)



• Figure 20B. Rear Logic Panel (Card Side), Machines After EC 252719

The rear logic panel (Figures 19 and 20) contains logic cards and associated wiring, and houses the rear CE panel. Mounted under the gate is a blower housing which provides air circulation within the logic panel. The DC CP (circuit protector) panel is fastened to the hinged side of the gate.

The card layout for tape units manufactured prior to EC 252719 is shown in Figure 20A; these tape units have a separate read preamplifier gate mounted between the vacuum columns in the front of the machine (see Figure 16). Tape units at EC 252719 level have read preamplifier circuitry incorporated in the rear logic panel as shown in Figure 20B.

The lower area contains the main power, convenience outlet, T/C shoe receptacles, and power switches and lights. Mounted above this is the motor control box (Figure 31), which contains the necessary AC CP's, relays, clutch filters, resistors, capacitors, and terminal block connections. Immediately behind this box is the AC raceway, which provides pluggable power to the drive motors.

Head Assembly (Figures 21 and 22)

General Description

The head assembly is constructed on two castings or plates. The lower plate is stationary, and the upper plate moves up and down under power. The two-gap read-write head, the tape break light, and the tape cleaner are on the lower plate. The load point and end-of-reel photocell assemblies, split guides, H-shield, and erase head are on the upper plate. The shield prevents interaction between the read and write sections of the two-gap head.

The upper plate swings upward from the lower plate to allow threading of tape when the tape unit is in an unload status and to provide free movement of tape during high-speed rewind. When tape is transported through the machine for reading or writing, the upper plate is down, and the tape is held in close contact with the read-write head. The upper plate assembly is swung open and closed by a worm drive, which is belt-driven from a motor at the rear of the clutch frame. When the upper plate of the head assembly is fully closed, positive locking is provided. Two micro-switches sense the status of the head assembly. Connections to the read-write head assembly, photocells, lights, etc., are made through three multipin connectors.

Figure 23 shows the basic differences between the head assemblies for the IBM 729 II, V and 729 IV, VI Magnetic Tape Units.

Visual Inspection and Operational Check

Inspect the head for uneven wear, scratches, nicks, and oxide build-up. Check for loose cable connections.

Check head up-down limit switches by performing tape load and unload operations.

Measure the read coil output of each track with the tape unit in a write operation. This output should be 15 to 30 millivolts, peak-to-peak, with each pulse width less than 20 μs. Pulse symmetry of all seven pulses must be similar, and amplitude difference must not exceed ±5 percent.

Cleaning

Clean the tape transport mechanism at least once every eight hours, or after every ten full reel passes, whichever occurs first. Follow instructions given under "Tape Transport Cleaning." Materials required for tape transport cleaning are available in a tape cleaning kit, P/N 352465. Individual items are listed in 729 Service Aid 260.

CAUTION

When cleaning the transport area, do not allow the tape transport cleaner to come into contact with the magnetic tape.

DANGER

Exercise caution when using tape transport cleaner, P/N 517960. Be familiar with *GP General/Safety CEM 25* or *729 Service Aid 162*. Avoid prolonged or repeated contact of tape transport cleaner with skin.

Lubrication

Apply IBM 20 grease to the worm gear assembly used to drive the head assembly up and down.

Use IBM 6 lubricant on all pivot points and felt pads.

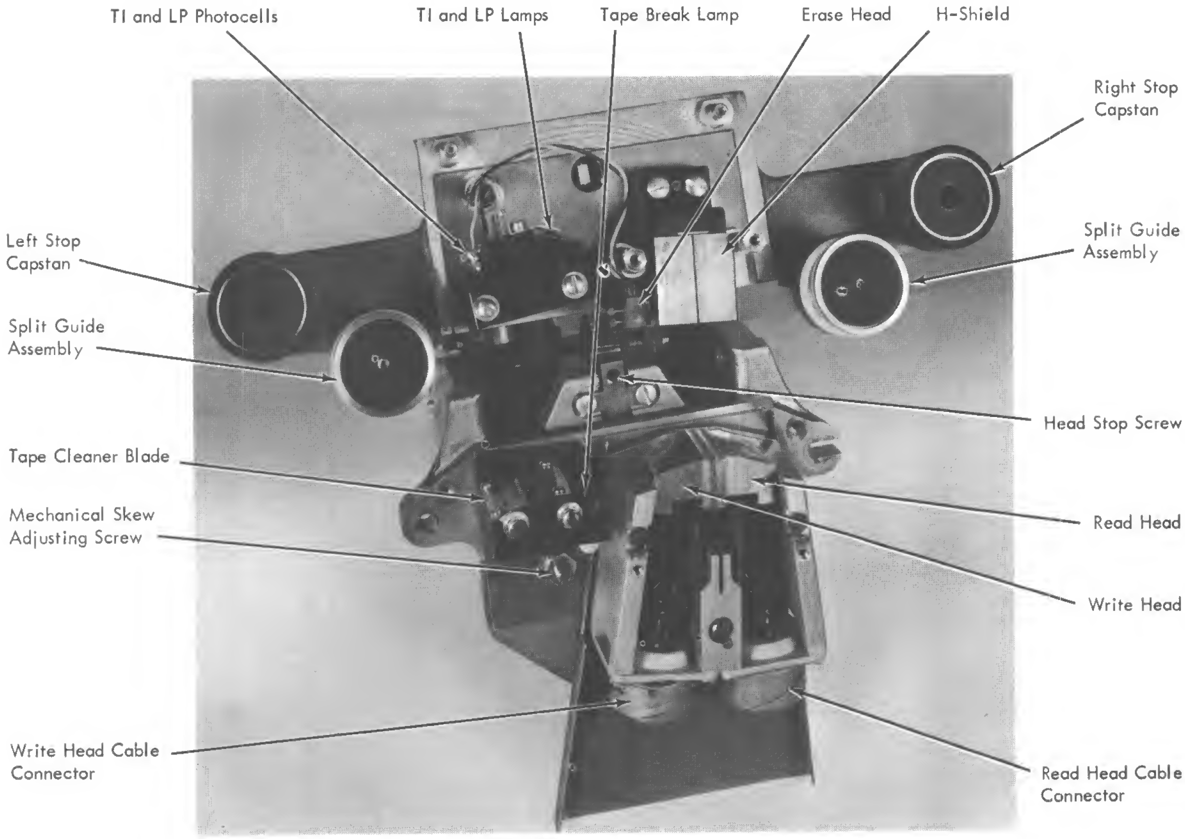
Adjustment, Head Limit Switches

Head limit switches are adjusted with the read-write head assembly removed from the machine. Adjust as follows:

1. Close the head and lock. Set the head-down limit switch so that the normally open contacts just transfer and make contact. This is accomplished with the switch bracket adjusting screw.
2. Turn the adjusting screw one-half turn counterclockwise, to insure switching transfer just before reaching the lower limit of travel.
3. With a 0.030 ±0.10 inch shim between the gear segment and stop spring, open the assembly to its full open position. Now, set the upper limit switch so that the wired normally open contacts just transfer. Do this by loosening the switch mounting screw and nut, and rotating the switch.

Removal, Head Assembly

Remove upper and lower decorative head covers. Pull the upper cover forward and upward. Remove the two screws from the lower cover.



• Figure 21. Head Assembly, Front View

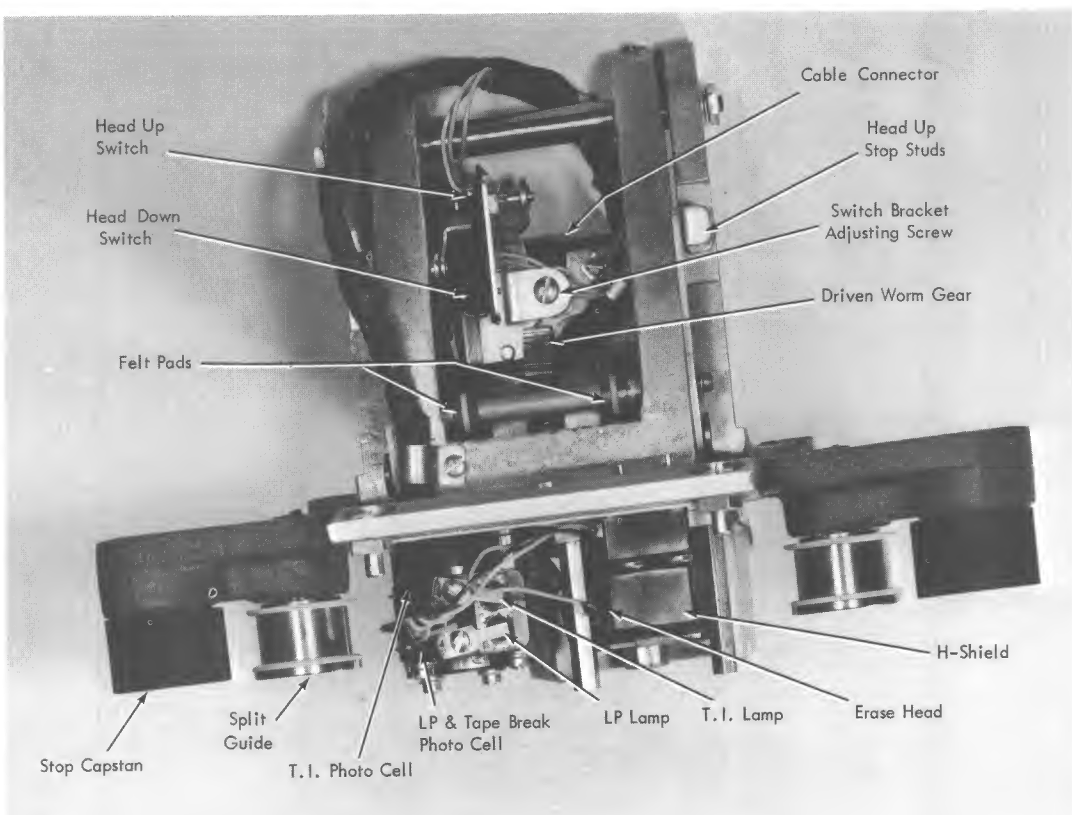
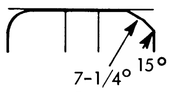
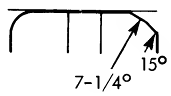


Figure 22. Head Assembly, Top View

HEAD COMPARISON CHART		
Type Head	729 II and V Two Gap	729 IV and VI Two Gap
1. Head Configuration		
2. Write Gap (inches)	.0005	.0005
3. Read Gap (inches)	.00025	.00025
4. Write Track (inches)	.048	.048
5. Read Track (inches)	.030	.030
6. Materials in Contact with Tape	+Hy -Mu 80, phos. bronze, Havar *, epoxy	Hy-Mu 80, phos. bronze, Havar, epoxy
7. Write Turns	100 turns C.T. #42	100 turns C.T. #42
8. Read Turns	180 turns #42	120 turns #42
9. Write Current (ma)	70 ma	70 ma
10. Output	15-30 mv	15-30 mv
11. Tape Speed	75 ips	112.5 ips
12. Recording Density	200 bpi (15 kc) 555.5 bpi (41.7 kc)	200 bpi (22.5 kc) 555.5 bpi (62.5 kc)
13. Intertrack Shielding	Write (2) .0075 phos. bronze and 3 pcs. .002 Hy-Mu 80 sandwiched	Write (2) .0075 phos bronze and 3 psc. .002 Hy-Mu 80 sandwiched
14. Track Pitch	.070	.070
15. Dist Between Gaps (inches)	.300	.300

+ Trademark of Carpenter Steel Corp.
* Trademark of Hamilton Watch Co.

• Figure 23. Head Comparison Chart

Remove the inner cover from the read-write head. Unplug the head cables.

Remove the three nuts and flat washers that hold the assembly to the tape frame casting. Pull forward to remove the complete assembly.

DANGER

The upper head, if it is up, will snap shut from its own weight when the head assembly is disengaged from the jackshaft assembly and is pulled forward.

Replacement

Replacement procedures are the reverse of removal procedures except as follows.

1. When replacing the head assembly, keep it in the unlatched position to make replacement easier.

2. Be sure to line up the keys in the read head and write head sockets with the keyways in the plugs. The keys are located towards the rear of the sockets. Push up on the plugs and turn the connector rings clockwise.

3. Make sure that head casting is seated evenly on the tape frame casting mounting studs before tightening the mounting nuts.

4. Check skew for mechanical alignment of head; check track C with track 1 only. Do not make any skew adjustments until you are sure that the head assembly is correctly and evenly installed.

Before a skew adjustment is made, the head locking screw must be loosened to remove slack in the skew adjusting screw. After the adjustment is made, tighten the head locking screw until it seats against the lower casting and all the slack is removed from the adjusting screw. Recheck skew adjustment for proper tolerance after tightening the head locking screw.

The complete skew adjustment procedure is described in the Skew section.

Note: Except for the ceramic guides, all parts on the upper plate of the head assembly can be replaced without replacing the entire assembly. The tape cleaner blade, and the head-up and head-down microswitches can also be replaced separately.

Two-Gap Read-Write Head

The two-gap head used in IBM 729 Magnetic Tape Units contains seven adjacent write heads in laminated form (Figure 24). The assembly also contains seven read heads. The two groups of heads are positioned so that the gap in the write heads is 0.3 inch to the left of the gap in the read heads. Tape passes over the head assembly, oxide side down, to complete the flux path of the write and read heads. Separate writing and reading heads permit reading of a record for checking while it is being written.

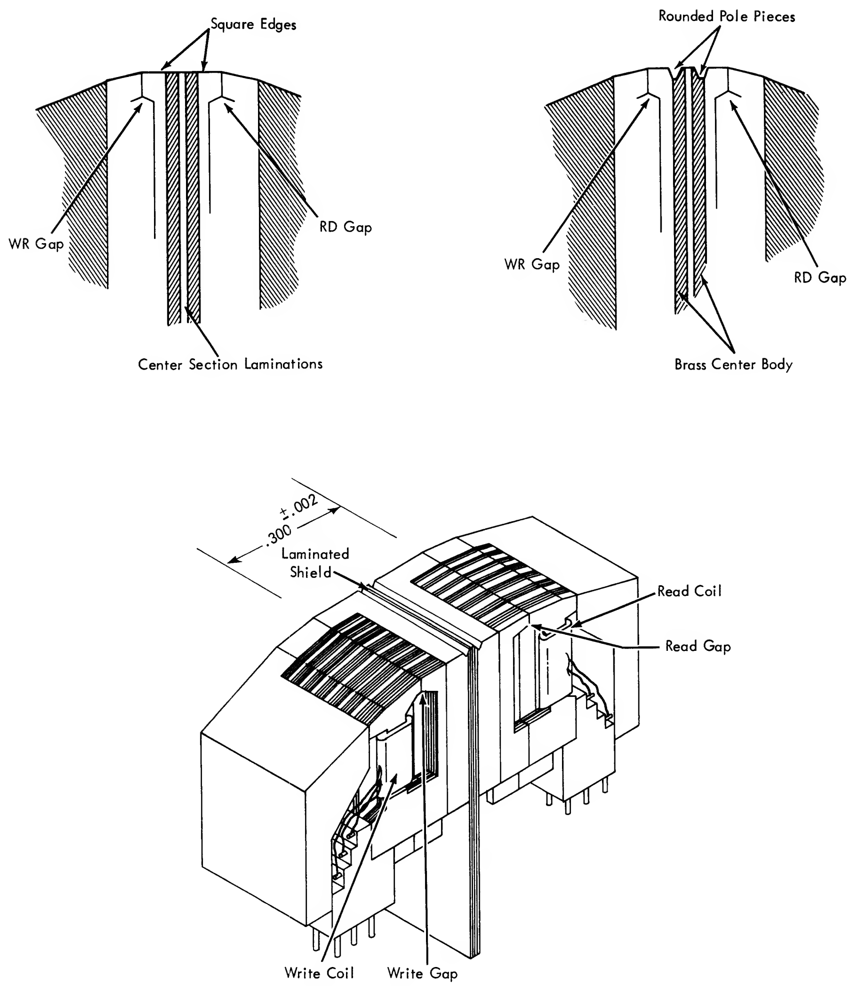
To provide for interchangeability of tape among tape units using the two-gap head, the read head must read a track that is narrower than the write track ("write wide read narrow"). The width of each write track is 0.048 inch, the read track is only 0.030 inch wide: a safety factor of 0.009 inch exists on each side of the read track.

Erase Head

Although old information is destroyed automatically as new information is written in each track, an erase head applies a strong magnetic field across the entire width of the tape during a write operation.

Using an erase head provides the following advantages:

1. Elimination of cross-talk caused by physical differences among the read-write heads on different tape units.
2. Reduced possibility of leaving bits in an inter-record gap or skip area.



• Figure 24. Two-Gap Read-Write Head

Modified Read-Write Head Assembly

Recently, read-write head assemblies have been modified by undercutting the head surfaces at the point where the pole piece laminations meet the brass body, in the center section of the head. This modification lessens the possibility of writing or picking up low amplitude noise (minor bits). In addition, rounding the edges of the laminations has reduced the tendency toward base line shift.

Visual Inspection and Operational Check

Inspect surfaces for pits, scratches, tarnish, and uneven wear. Uneven or worn surfaces provide poor tape contact and cause low signal strength, resulting in read-write errors. Passage of tape across the head causes physical wearing of the assembly. This trenching of the head surface can be recognized by:

1. Excessive fluttering of the 1 and C bit bus signals.
2. Buildup of shoulders (trenching) on the head. These are visible in bad cases, but can be felt with the fingernail in almost all cases.
3. Unexplained increase in tape checks. This will probably be one of the first symptoms.

The decision to replace a worn head is left to the customer engineer, who is in the best position to decide in an individual case. It is emphasized, however, that the head assembly is an expensive part. Replace only heads that actually cause excessive errors. Always replace the entire head assembly when head replacement is indicated.

Cleaning

Clean the entire head, transport unit, and vacuum columns thoroughly with tape cleaner. In cleaning the head, always wipe it in the direction of tape movement. Make sure the head is clean before performing skew and preamplifier adjustments. Amplitude can increase 10 to 40 percent as oxide builds up on the head. When cleaning the head, also clean the underside of the ceramic guide with a typewriter brush.

Removal and Replacement

For removal and replacement of the read-write head see "Head Assembly." The read-write head assembly should be replaced when:

1. Output cannot be brought within specifications (amplitude and skew).
2. The head is worn (trenched).

H-Shield Feed-Through

Feed-through is signal pick-up on the read head from the write head when the tape unit is in write status.

Adjustment

The H shield (Figure 25) should be adjusted for minimum feed-through as follows:

1. Suppress go in off-line status.
2. Write ones on all tracks from the CE panel.
3. Observe the signal on the read bus.
4. Adjust the H shield for minimum feed-through signal on all channels.
5. Feed-through specifications for 729 II, IV, V and VI are ≦0.4v peak to peak.
6. When a tape unit is adjusted for minimum feed-through, excessive temporary write checks may occur because of the position of the H shield. If the center of the H shield is located to the left of the center laminations of the head (Figure 26), extra bits can be introduced into TAU register B. This shows up as a bit pickup and gives a compare error, causing the temporary write check. To correct this condition, the H shield should be moved to the right, so that the center of the H shield is to the right of the center head laminations. This must be done even though minimum feed-through is sacrificed.

Cleaning

The underside of the H shield should be cleaned with a typewriter brush.

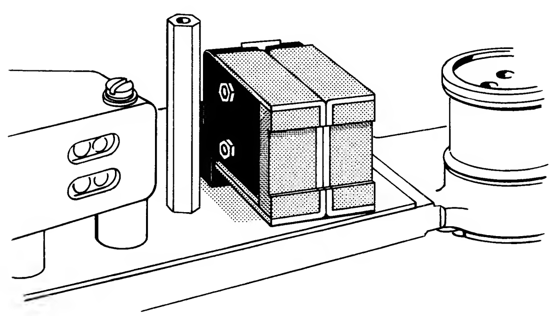


Figure 25. H Shield

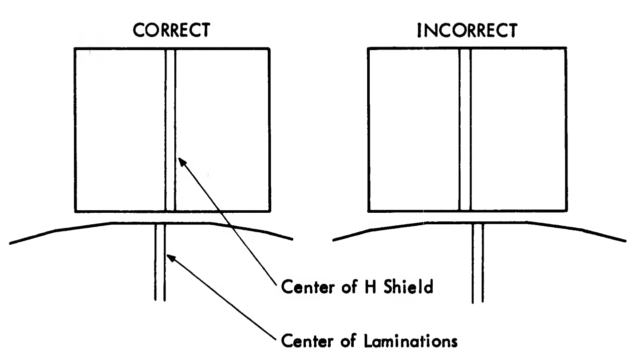


Figure 26. H-Shield Adjustment

Erase Head

Theoretically, an erase head is not necessary, because old information is automatically erased by the writing of new information; an erase head is provided, however, to reduce the possibility of bits being left in an inter-record gap or skip area. Because of its wider coverage and stronger force, the erase head more completely erases areas of tape that have been lifted slightly from the head by foreign particles or air bubbles trapped between the tape and head.

Adjustment

Remove the H shield from the head assembly and position the brass mounting bracket as far to the left as possible.

With the head and guide assembly closed, and with tape out of the transport area, place a 0.005-inch shim across the cleaner block and head. Lower the erase head until it comes in contact with the shim. At the same time, position the head to the extreme left and clockwise about its mounting screw.

This shim will locate the erase head 0.003 (+0.001, −0.000) inch above the tape. The shim must be straight to follow the line of tape movement. Do not force the head down on the shim; this could cause the shim to deflect and produce an incorrect adjustment.

Operational Check

Erase head operations and polarity can be checked by the following short program:

Polarity Test:

1. Skip twice to clear an area of tape.
2. Write a record (A) to be used later for comparing (1 word or 5 characters).
3. Rewind.
4. Write a record (B), the same record used at 2.
5. Backspace.
6. Read over record B (written item 4).
7. Read again—Record A (item 2) should be read. If erase head polarity is reversed, all 7 bits will be read as a result of the backspace (item 5).
8. Compare read-in area with the write area (record A).
9. If equal, the erase head is correct.

Operation Check:

1. Clear A field to zero.
2. Write a long record, 1,000 to 2,000 characters.
3. Backspace.
4. Write one word or five characters.
5. Read into A field.
6. Compare a zero field (constant) to A field while the reading is taking place.
7. If equal, add one to the accumulator and transfer back to item 6.
8. If unequal, the first bits of the B record written at item 2 have been read.
9. Compare the result in the accumulator to a constant (established for each system or tape model).
10. If the count is higher, the erase head is working. The distance from the read head to the first bits of record B will be longer when the erase head is working.

Skew

Even though the tape transport and read-write assemblies are assembled with the utmost precision (to 0.0001 inch in some cases) it is almost impossible to cause all bits of a character to be written or read simultaneously across the face of the magnetic tape. In some cases, there is a time difference between the recognition of the various bits. This condition is called skew.

Skew can result from both mechanical and electrical factors. If the seven read-write heads are not mounted exactly perpendicular to the magnetic tape motion, the character will be written at an angle across the tape instead of at exactly 90° to the edge (Figure 27).

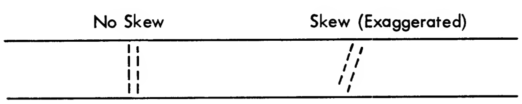


Figure 27. Tape Skew

If skew becomes too great (especially where high densities are used), there can be an overlapping of characters, resulting in tape errors.

Electrical wires and electronic circuits have inherent delays. As a result, the various bits of a character may be separated timewise between the instant they are read and the time they are received by the controlling unit. If these delays are excessive, tape errors will result.

Skew checks can also be caused by extreme differences in preamplifier settings, wear in the left nylon idler, or a dirty split guide.

Mechanical and electrical adjustments are provided to compensate for skew. Skew must be adjusted in the following order: mechanical, read, write.

Operational Check and Adjustment

Check skew adjustments every 13 weeks or more often if indicated by poor machine performance. Check skew whenever any parts are changed in the transport area. These parts include nylon idlers, forked arms, and prolays. Skew between leading and lagging tracks must be less than 0.25 μs. Before checking skew:

1. Adjust the prolays.
2. Clean the tape transport, capstans, nylon pulleys, rewind idlers, ceramic guides, tape cleaner blade, and

read-write head, using a lint-free cloth and approved cleaning solution.

3. Calibrate the oscilloscope.
4. Compensate the oscilloscope probes.

Measurement Technique

When checking or adjusting skew, observe the following:

1. Use the maximum vertical gain possible on the oscilloscope; if necessary, use direct probes.
2. To display small amounts of skew more easily, use the vertical position control to pass one oscilloscope trace through the other.
3. When using master tape, use a full pass to insure even wear throughout.
4. Make skew adjustments with tape unit "on line," scoping at TAU final amplifier test points, if possible.

Adjustment, Mechanical Skew

1. Mount master skew tape. Use 556 BPI tape, P/N 461096, for 729 II and IV. Use 800 BPI tape, P/N 461197, for 729 V and VI.
2. Return all read delays to zero. (This is omitted if checking only.)
3. Check that all preamplifier outputs are equal. The amplitude will depend on the condition of the master tape. Adjust if necessary. When adjusting skew using Tektronix 310 oscilloscope and 60 c/s chopper, reset the amplitude of the reference track after final checking. Whenever possible, use Tektronix 561 with chopped sweep instead of the Tektronix 310. Do NOT use alternate sweep setting.
4. Connect an oscilloscope and check 1 and C bits. Sync on the 8 bit to prevent unequal loading of 1 and C bit circuits, and reduce trace "jitter."
5. Loosen the head locking screw and adjust the vernier screw for coincidence of the 1 and C bits. Make sure that 1 and C bits being scoped are both in the same character. This may be done by comparing A and 4, B and 2, C and 1.
6. Tighten the head locking screw and recheck to be sure that the adjustment has not changed.

Adjustment, Read Skew

Proper mechanical skew is a prerequisite. Read skew is always checked or adjusted before write skew.

To adjust read skew:

1. Using the master skew tape, return all read delays to zero.
2. Check preamplifier outputs as in step 3 of the mechanical skew adjustment procedure.
3. Determine which track is lagging most (last bit) and synchronize the oscilloscope on this track. The sync point should be electrically "beyond" the read bus to prevent additional loading of the read bus circuit.
4. Adjust the read delays for optimum coincidence of each track with the most lagging track. The most lagging track must occur within 0.25 μs of the leading track.

Adjustment, Write Skew

On all 729 models, read skew must be set before adjusting write skew. On 729 V and VI, time asymmetry must also be adjusted before setting write skew. (See section: "IBM 729 V and VI, Magnetic Tape Units.")

To adjust write skew:

1. Mount a reel of tape known to give good performance.
2. Return all write delays to zero (not necessary if performing only operational check).
3. Write ones on all tracks, at high density.
4. Connect the oscilloscope to the read bus and observe all tracks.
5. Determine the most lagging track (last bit) and sync on it. The sync point should be electrically "beyond" the read bus, to prevent additional loading of the read bus circuit.
6. Adjust the write delays so that all tracks coincide with the most lagging track.
7. Reset write triggers after moving taps, to insure that all tracks are being written in phase.

Operational Check of Skew

Skew can be checked either on the read bus or at the output of the read register in TAU or the data synchronizer. When checking skew, always use ones written on all tracks; random information should not be used.

For measurement only, the read register output may be the most convenient point to observe because it will display a sharp pulse waveform.

When skew is thought to be within the final amplifier, the following checking procedure can be used: Feed *one* track from the tape unit to the suspected track and to another that is considered correct (jumper the two final amplifier inputs together). Two tracks can be jumpered together at the edge connectors on the preamplifier panel in the tape unit.

To detect skew from the left nylon idler, scope tracks 1 and C syncing on track 8. Apply sufficient finger pressure against the left fork arm to take up any existing end-play in the fork arm. Flick the left nylon pulley (using snapping action with thumb and index finger) while reading the master tape and monitoring skew.

If skew between 1 and C changes and remains changed until flicked again, replace the nylon pulley.

Always check skew whenever a nylon pulley is replaced. If skew is off after installing a new pulley, be certain the new pulley is not at fault before adjusting mechanical skew.

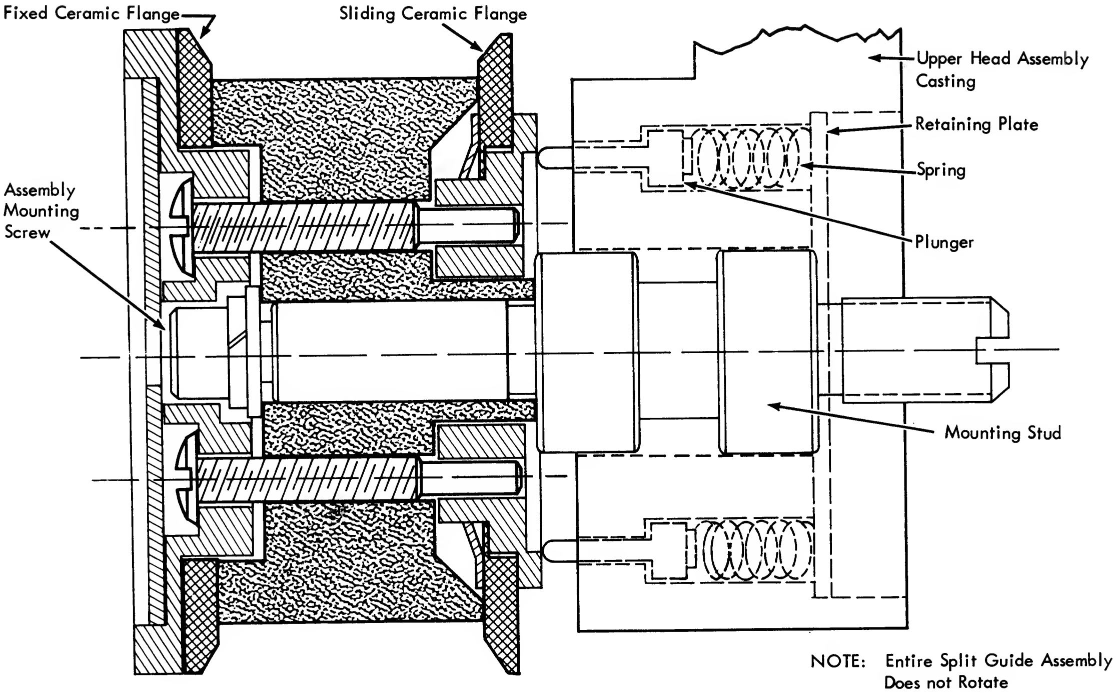


Figure 28. Split Guide Assembly

Split Guide Assembly

Two split guides (Figure 28) maintain proper alignment of the tape as it passes over the read-write head. They are located on the upper head plate to the right and left of the head assembly. The split guides keep the tape parallel (at a fixed distance) to the front casting. Alignment between machines can be closely controlled. To avoid complex systems, alignment is maintained only to one edge of the tape. The stationary part of the guide holds the front edge of the tape at a fixed distance from the front casting. The rear portion of the guide is free to slide on the shaft and is held in continual contact with the rear edge of the tape by three spring-loaded plungers which protrude from the upper head assembly casting.

When the tape expands in width, it spreads the split guide. The track farthest away from the front edge of the tape is most subject to misalignment when the tape expands or contracts laterally between the time of recording and the time of reading.

The inner flange surfaces of the split guides are lined with a ceramic material that is highly resistant to wear from tape passing over the guide at high speed. The entire split guide assembly is permanently mounted; it does not rotate when tape passes over it.

Visual Inspection and Operational Check

Check the front and rear ceramic washers for cracks, chips, and dirt. Check for loose mounting screws and physical damage to the metallic surface over which the tape is transported.

Cleaning

Clean split guides with the small brush and inspect with dental mirror.

Removal

The entire assembly is never removed from the head casting. Only the guide hub and ceramic washers are disassembled in the field. To remove the guide hub and ceramic washers:

1. Insert a 5/64-inch Allen wrench into the face of the guide hub.
2. Loosen the Allen screw and remove the hub.
3. If the assembly is removed for cleaning only, mark the relative position (with pencil or other marker) of the hub and ceramic washers.

Replacement

Replace the hub and ceramic washers by reversing the removal procedure. Be careful not to overtighten the center body screw, because it may break.

CAUTION

Never tamper with Glyptal* cement covering the guide mounting stud on the back side of the head assembly casting. Disturbance of the guide mounting stud alters tape alignment and affects skew.

Tape Cleaner Blade

The tape cleaner blade (Figure 30) is mounted on a phenolic block, positioned so that forward-moving tape

*Trademark of General Electric Company.

passes over the blade before reaching the surface of the read-write head. Foreign matter and clumps of loose oxide on the surface of the tape fall through the perforations of the blade and collect in the phenolic block aperture.

Visual Inspection and Operational Check

A tape cleaner blade must be in good condition to remove foreign matter and worn particles of tape. Inspect the blade periodically for signs of physical damage and wear, after removing the upper decorative cover by pulling it forward. Blades showing the following indications should be replaced:

Damage: Replace any blade with nicks, scratches, dents, or any surface defect that could damage tape or cause oxide buildup in the head area.

Wear: Determining when a tape cleaner blade should be replaced because of wear cannot be sharply defined. A worn tape cleaner blade does not clean tape effectively, and can actually damage tape by shaving long slivers from the edges of the tape.

Replace the blade whenever there is any evidence of shoulder buildup (trenching) the width of tape. Trenching is likely to cause problems after about six months of a maximum-shift usage, or 9 to 15 months of average use.

Cleaning

Clean the blade by rubbing lightly with the small brush or typewriter brush. Remove accumulated particles from the aperture with a cotton-tipped swab.

Replacement

CAUTION

The mounting position of the tape cleaner block establishes the tape approach angle. Never remove or disturb the tape cleaner block mounting screws when changing the tape cleaner blade. The silver polish method is not an accurate means of restoring the correct tape approach angle once this adjustment has been lost.

To replace the tape cleaner blade:

1. Remove the mounting screws from the load-point and tape-indicate photosensing assembly, and carefully swing the assembly aside.
2. Manually lower the head for better access to the tape cleaner blade.
3. Remove the four blade mounting screws, and slide the old blade out. Try not to disturb the grounding strap.
4. Install the new blade, and replace the photosensing assembly.
5. Run at least two full reels of work tape across the new cleaner blade before returning the tape unit to the customer. In a few cases it may be necessary to extend the wearing-in process to remove any roughness that might scrape oxide from the tape.

Tape Approach Angle

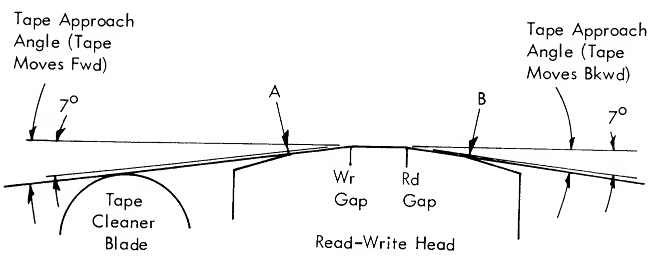
The relative positions of the two-gap read-write head and the tape cleaner blade establish the angle at which tape approaches the read-write head surface (tape approach angle) (Figure 29). Head assemblies are adjusted at the factory to establish the correct approach angle of about 7¼°. This setting produces very slight "wrapping" or bending of tape where it passes over the outer apexes of the read-write head surface, reducing the likelihood of trapping an air bubble between the tape and the head surface. A trapped air bubble lifts tape from the head surface, causing read or write errors and possible erase failures in the inter-record gap. Such failures are most prevalent during start-stop operation. Too great a tape approach angle increases the area of head-to-tape contact, causing increased oxide buildup on the head surface.

Since facilities to adjust the tape approach angle are not available in the field, the entire head assembly must be replaced when the read-write head or the tape cleaner block needs replacing. Do not disturb tape cleaner block mounting screws; a worn or damaged tape cleaner blade can be replaced without disturbing the position of the tape cleaner block.

The following "silver polish" check for tape approach angle is useful as a rough check when diagnosing potential sources of tape unit errors. Do not attempt to use it for making adjustments or replacing individual parts of the head assembly. Contact the Poughkeepsie Plant Customer Engineering Department, or your district tape specialist if you encounter head assemblies that show symptoms of incorrect tape approach angle.

Check the Approach Angle as follows:

1. Apply silver polish (Gorham's or International Silver Polish is preferred) to the entire head surface sparingly; allow the polish to dry, forming a white powder.
2. Load a work tape (not intended for processing) and run continuously forward until there is about 1½ radial inches of tape on the machine reel; then low-speed rewind.



• Figure 29. Tape Approach Angle

3. Unload the tape unit and observe the head; the powder will be wiped off the head where the tape has contacted the surface. Visual inspection should show that the apex at point A (Figure 29) has been wiped completely clean, indicating a tape approach of just over 7°.

4. Clean the tape transport and columns thoroughly with tape transport cleaner to remove any polish that is deposited.

Check for Air Bubbles as follows: A normal start-stop setup is used, reading all bits. In extreme cases, the air bubble can be detected at the read head. It will show as a dip in the normal waveform envelope (Figure 45 I). The time from GO depends on whether the angle is less than 7¼° (largest exposure is here) or more than 7¼°. (This angle has to be radically incorrect, to about 10°.) If the wrap angle is small, the dip in the envelope will appear about 7 ms to 8 ms from GO. A large wrap angle will produce a dip about 12 ms from GO.

Frequently, this loss in contact cannot be detected at the read head. The write head can be used to "read" the signal for detecting the bubble. Disconnect one or more tracks (three wires each) of the write head at the edge connectors in the logic gate. Observe the output of the opened write tracks on a scope. A direct probe—and possibly a high-gain preamplifier in the scope—is necessary. The envelope will be similar to the usual start-stop envelope. A distinct decrease in amplitude, by as much as 50 percent, or even to zero, indicates loss in contact.

The read head should be used for detecting loss in contact when tape is moving backward.

Incorrect wrap angle can cause excessive read or write errors, and possibly bits in the inter-record gap. It is recommended that head assemblies causing such failures be replaced by a new assembly.

Photosensing

Three photocells and four associated lights are located on the head assembly or in the immediate area. Light, either shining directly at or being reflected to the photocells, indicates to the system specific physical tape conditions.

Lamps, direct sunlight, or other extreme lighting conditions can cause marginal problems in photosensing circuits.

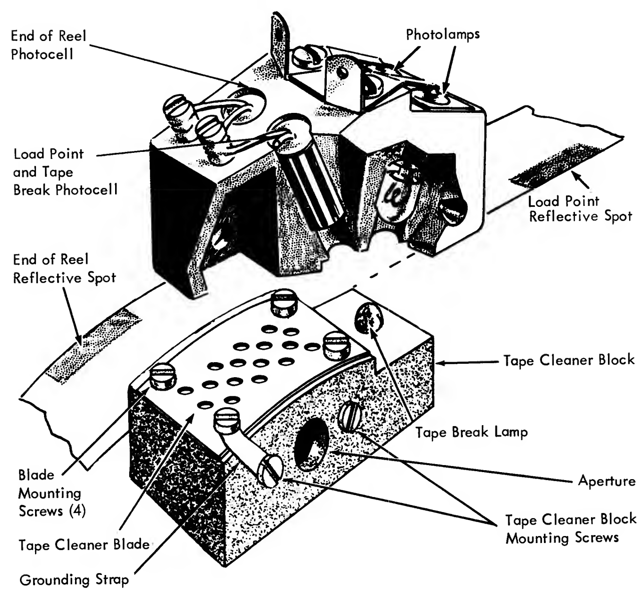
High-Speed Rewind Photosensing

A photocell and light are used to determine the type of rewind that the tape unit will do. The photocell is in the lower section of the finger guard (Figure 16). The light is on the right corner of the top plate; its beam is directed on the photocell. When more than ½ inch of tape is on the machine reel, the light path is blocked and tape rewind is at high speed (average—500 inches per second). When less than ½ inch of tape is on the machine reel, rewind is at low speed (normal tape speed: 729 II and V, 75 inches per second; 729 IV and VI, 112.5 inches per second). During a high-speed rewind, when about ½ inch of tape remains on the machine reel, tape is electrically braked to a stop. The tape is then lowered into the vacuum columns, and rewinding is completed at low speed.

Load-Point Photosensing

The load point is a small reflective spot (3/16 inch × 1 inch), placed on the plastic side of the tape (1/32 inch from the front edge and 10 feet from the physical beginning of the tape). This reflective spot locates the beginning of the usable portion of the tape. The ten feet of tape preceding the spot is for threading the machine reel.

The load point reflective strip is used during a backspace or rewind operation. It is sensed by a photocell arrangement (Figure 30). Light from the front bulb is reflected from the spot to the photocell directly to the left of it.



• Figure 30. Tape Cleaner Block and Photosensing Assembly

End-of-Reel Photosensing

The end of the usable portion of a reel of tape is indicated by a reflective spot about 18 feet from the end of the tape. This spot is placed on the plastic side of the tape 1/32 inch from the back edge. The photocell (Figure 30) senses this reflective spot. If the tape unit is in write status when the end-of-reel reflective spot

is sensed, a tape indicator trigger is turned on. If the tape unit is in read status when the reflective spot is sensed, there is no indication.

Tape Break Photosensing

During a high-speed rewind operation, tape passes between a light source on the lower head plate (to the left of the read-write head) and the load-point photocell. If the tape breaks, light strikes the load-point photocell, causing the tape unit to stop.

Visual Inspection and Operational Check

Visually inspect the high-speed rewind, tape break, tape indicator, and load point lamps for equal brilliance. Inspect photocells for physical damage. Access to the high-speed rewind lamp is provided through the control panel door. The high-speed rewind photocell is accessible after removal of the plastic finger guard cover between the two tape reels. Load point and tape indicator lamps are located in the photosensing block in the upper head assembly. The tape break lamp is mounted in the tape cleaner block.

It is possible for the photosensing cable assembly to be worn by the plastic dust shield mounted on the 729 base. This occurs when the head is raised and the cable assembly is pinched between the head and dust shield. This condition can be corrected by insuring that the cable clamp positions the cable out of the way.

To check the load point and tape indicator circuits, position two reflective spots on the tape about six inches apart and place tape unit in the write auto-cycle mode. The tape unit will reverse direction each time a reflective spot is sensed. The tape break circuit can be checked by placing masking tape over the high-speed rewind photocell and an opaque card across the read-write head and tape cleaner blade. After the file reel begins to rotate, remove the card. The file reel should stop.

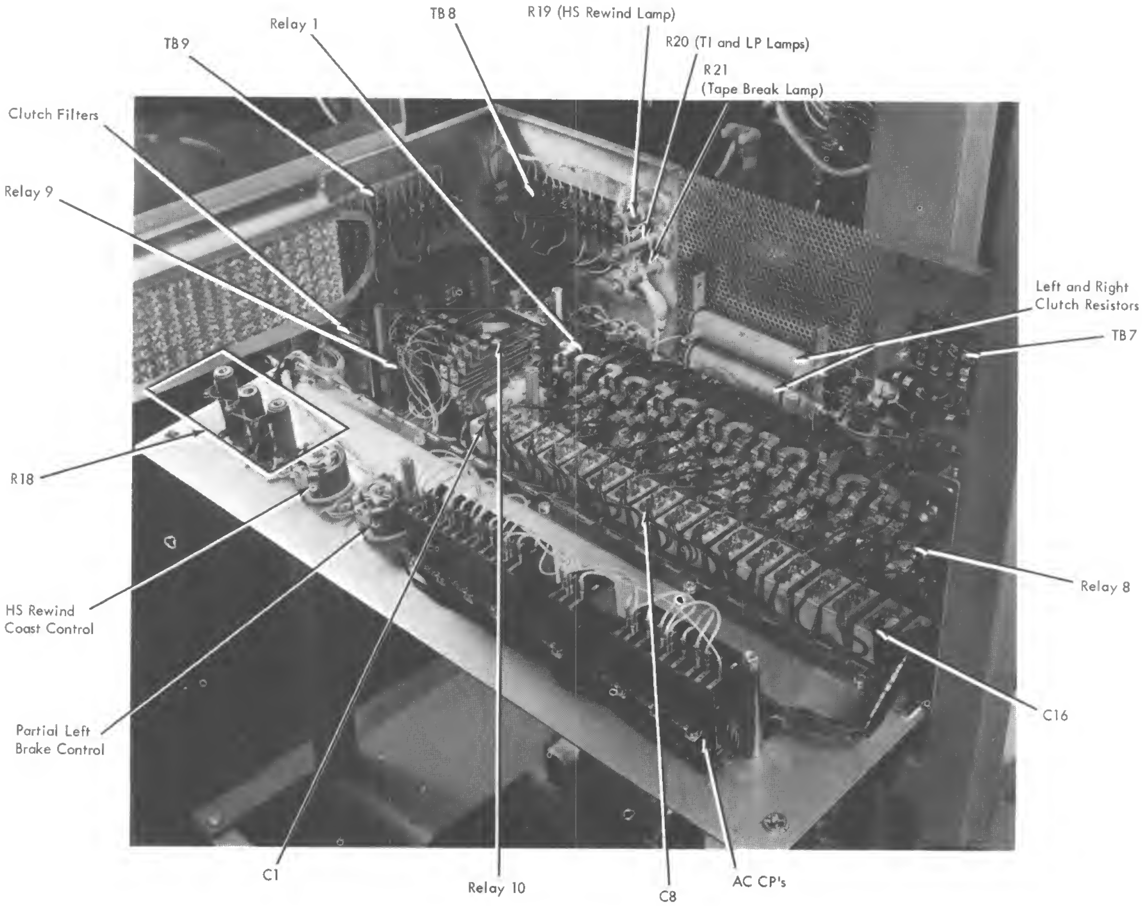
Adjustment, Load Point, Tape Indicate, and Tape Break Lamps

Adjust R20 (Figure 31) so that the voltage across the load-point and tape-indicate lamps (with tape in columns) is 5.0 to 6.5 volts. (This voltage can also be measured from frame ground to the load side of R1.)

Set R21 for 2.5 to 3.0 volts across the tape break lamp.

Adjustment, High-Speed Rewind Lamp

Adjust R19 with its sliding tap so that the voltage at A3D10D is 0.0 ±0.2 volts (TU.09.30.1).



• Figure 31. Motor Control Box (Machine After EC 250259)

Removal, High-Speed Rewind Lamp

1. Remove the plastic cover by loosening the retaining thumbscrews.
2. Remove the lamp from its socket.

CAUTION
Be careful not to damage lamp and socket; both are fragile.

3. Removal of the high-speed rewind lamp is easier if approached from the rear of the machine.

When the high-speed rewind lamp cover is replaced, it often moves wires going to the lamp, and, in turn, the lamp in its socket, changing the aim of the light beam. The high-speed rewind lamp must be focused on its photocell. Install a small cable clamp to hold the wires rigid, or just tuck the excess wire into the angle of the mounting bracket.

Removal, High-Speed Rewind Photocell

1. Snap open the finger guard by pulling forward and twisting.
2. Remove the retaining clip and screw.
3. Using long-nose pliers, unplug the photocell from its socket.

Removal, Load-Point and Tape-Indicate Lamps

1. Raise the head assembly.
2. Snap off the upper decorative cover.
3. Loosen the retaining spring and screw.
4. Rotate the retaining spring out of the way and remove the lamp.

Removal, Load-Point and Tape-Indicate Photocells

1. Raise head assembly.
2. Snap off the upper decorative cover.
3. Unsolder the leads and remove the photocells.

Removal, Tape Break Lamp

1. Remove the lower head decorative cover.
2. Loosen the lamp retaining spring and screw on the underside of the tape cleaner block.
3. Rotate the spring out of the way and catch the lamp as it falls from its position.

Rewind Idlers

Cleaning

Clean with a lint-free cloth and the approved cleaning fluid. Remove clumps of oxide, which build up in the crevices of the rewind idlers, to prevent their being thrown into the transport. The SMS Back Panel Probe, P/N 461262, makes an excellent tool for removing oxide clumps. The flat end can be filed to a chisel point, which, being plastic, can be used to remove oxide without risk of damaging metal surfaces.

Visual Inspection and Operational Check

Check rewind idlers for binds. The idlers must spin freely, without excessive endplay.

Removal

1. Remove the capstan motor. See "Drive Capstans and Motors."
2. Remove two mounting screws.
3. Remove the rewind idler.

Preamplifiers

Before adjusting preamplifiers, calibrate the scope, and compensate the scope probe or use a direct probe. Clean the read-write head and transport area.

In making the adjustment, use either the standard signal level tape, P/N 461108, or an average tape that has had 10 to 100 pass usage. A check using the standard signal level tape is a means of testing the condition of the average tape used for normal gain adjustment. Typical waveforms while reading at 200, 556, and 800 BPI are shown in Figure 32.

Set the gain to an average of 8.8 volts peak-to-peak while writing all ones at 556 BPI (729 II and IV), or 9.8 volts peak-to-peak while writing all ones at 800 BPI (729 V and VI). Scope at the inputs to the TAU amplifiers to compensate for the signal losses between the tape unit and TAU. Adjust the gain potentiometer on each of the seven amplifier cards.

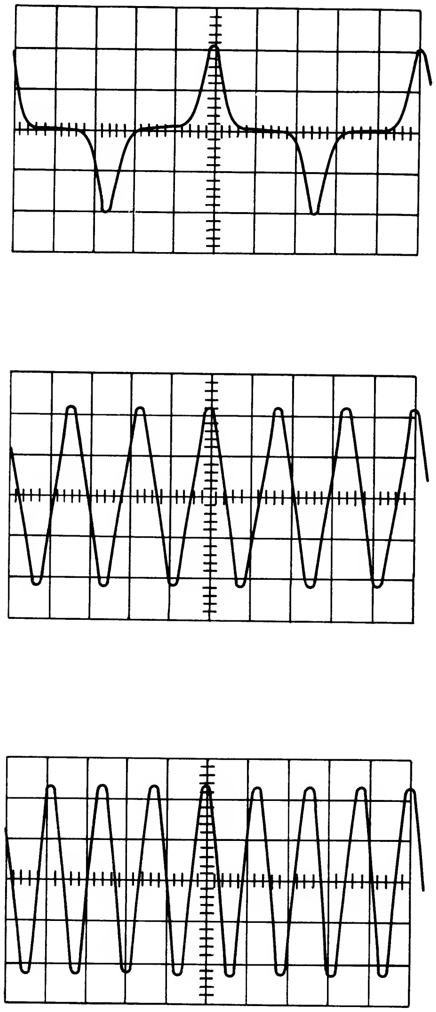
Preamplifiers must be capable of producing a minimum of 10 volts output with the gain potentiometer adjusted for maximum.

Preamplifiers may break into a 600 kc oscillation with an amplitude of 1 to 2 volts, particularly on the last tape unit of a line of five. This oscillation should not cause trouble because it is not recognized by the final amplifiers.

NOTE: When the NOR tape unit is off line and under control of the built-in tester, read gate is always held down, to prevent gating information out on the read bus. Because signal levels may vary between final preamplifier input pin G and output pin H (read bus), preamplifiers should be adjusted either:

1. On-line, using the system to read the master tape, or
2. Completely off-line (no signal cables connected), by tying logic panel pin 3H17P to ground. Grounding 3H17P causes the read gate to be up, allowing preamplifier output to be measured at pin H. When this setup is used, pin H must be terminated by a final amplifier card, as described in "Off-Line Check of Tape Unit Time Asymmetry."

Read preamplifier cards are not interchangeable between different models of the 729. Refer to Systems TU.04.11.0 for part numbers of cards used in each 729 model.



At 200 Bits/Inch

At 556 Bits/Inch

At 800 Bits/Inch

Read while writing continuous 1's
Direct Probe Centerline on 0v
2v/cm 20 us/cm
AC input
internal sync

• Figure 32. Read Preamplifier Waveforms

Head Raising Mechanism

The head assembly upper plate is driven up or down by energizing the three-phase head motor, mounted on the rear of the magnetic clutch frame (Figure 33). Motion is transmitted through a toothed belt, friction clutch, and worm gear shaft. Motor phasing determines the direction of head movement.

Operational Check

Turn off tape unit AC power, and check for binds by manually turning the head motor shaft to raise and lower the head at least once.

Lubrication

Lubricate the sector gear and worm gear with IBM 24. Lubricate the felt pads with IBM 6.

Tape Movement

Tape is transported from the file reel past the read-write head by the drive capstans and prolay idlers. It would be impractical to start and stop tape under control of the reel drive system because of the inherent sluggishness of this system.

Vacuum columns below the reels provide buffer storage areas. A loop of tape is retained in each of these columns. As tape is drawn from one column, it is replenished by the associated reel. As tape is pushed into the opposite column, the associated reel winds the tape. The control of reel motion and the reel drive is discussed later. Figure 34 shows the path of tape through the 729 tape unit.

Forward

The right and left drive capstans turn continuously in the direction shown. To move tape from left to right, the right prolay idler is pivoted to the right, squeezing the tape between the prolay idler and the right drive capstan. The left prolay idler is pivoted into a neutral position so that it does not obstruct tape movement.

Backward

To move tape from right to left, the left prolay idler is pivoted to the left, causing the tape to be squeezed between the prolay idler and the left drive capstan. The right prolay idler pivots to a neutral position.

Stop

To stop tape motion, the prolay idlers pivot toward the stop capstans, causing the tape to be squeezed between either the right or left prolay idler and the right or left stop capstan. If tape is being drawn from left to right (forward direction), it is stopped by the left stop capstan. If the tape is being drawn from right to left (reverse direction), it is stopped by the right stop capstan.

Prolay Assembly

Motion is imparted to the prolay idler by a prolay, which consists of three sets of electromagnets and an armature. The magnets are arranged so that the armature can assume one of three positions, depending on which set of magnets is energized. The motion of the prolay armature is transferred to the prolay idler and can cause it to move against the stop capstan or the drive capstan, or to a neutral position between the two capstans. Figure 35 shows a prolay energized in stop status.

Operation

The armature is pivoted (Figure 35) at the lower end of an arm. The prolay idler is attached to the upper

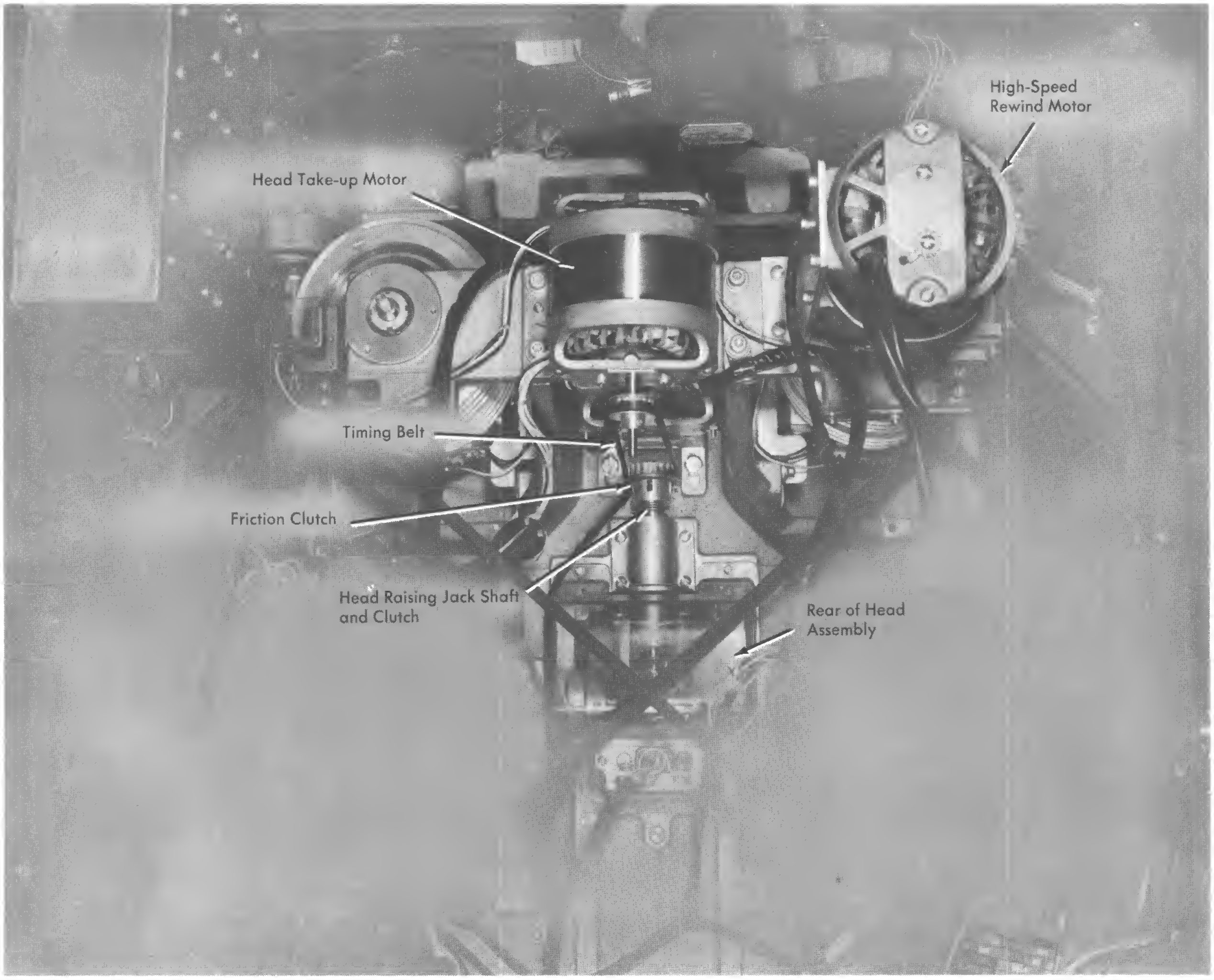


Figure 33. Head Raising Mechanism

end of the arm. With this arrangement a movement of the prolay armature will produce movement of the arm about its pivot point, causing the idler to change its position. Energizing the STOP magnets moves the prolay armature to the right, causing counterclockwise movement of the arm about its pivot. This causes the prolay idler to squeeze tape against the stop capstan.

When the NEUTRAL magnets are energized, the prolay armature assumes a slanted position as shown in Figure 36. This causes the arm to be in a vertical position, placing the prolay idler where it cannot contact either the drive capstan or the stop capstan. This is called neutral status.

Figure 37 shows the GO magnets energized, causing the prolay armature to move to the left while maintaining a vertical position. This produces clockwise movement of the arm about its pivot point, causing the prolay idler to squeeze tape against the drive capstan.

The previous description covers operation of the right prolay. Operation of the left prolay is similar except that the prolay arm is bent in the opposite direction and the positions of the STOP and GO magnets are reversed (Figure 38).

Operational Check—Tape Motion and Inter-Record Gap Test

The inter-record gap test checks the motion control section of the tape unit for adjustment or the need for scheduled maintenance. This is accomplished by writing a tape under varying GO down times and measuring inter-record gap sizes during the read pass.

The test consists of two sections:

1. The right prolay test (forward motion of tape).
2. The creep test, which insures that repetitive write-backspace-write operations do not cause the gap from the last record to become smaller.

Explanation of Graph (Figure 39)

Point A occurs by having GO down for the shortest possible time. This creates the largest gap because the prolay does not have time to respond and move away

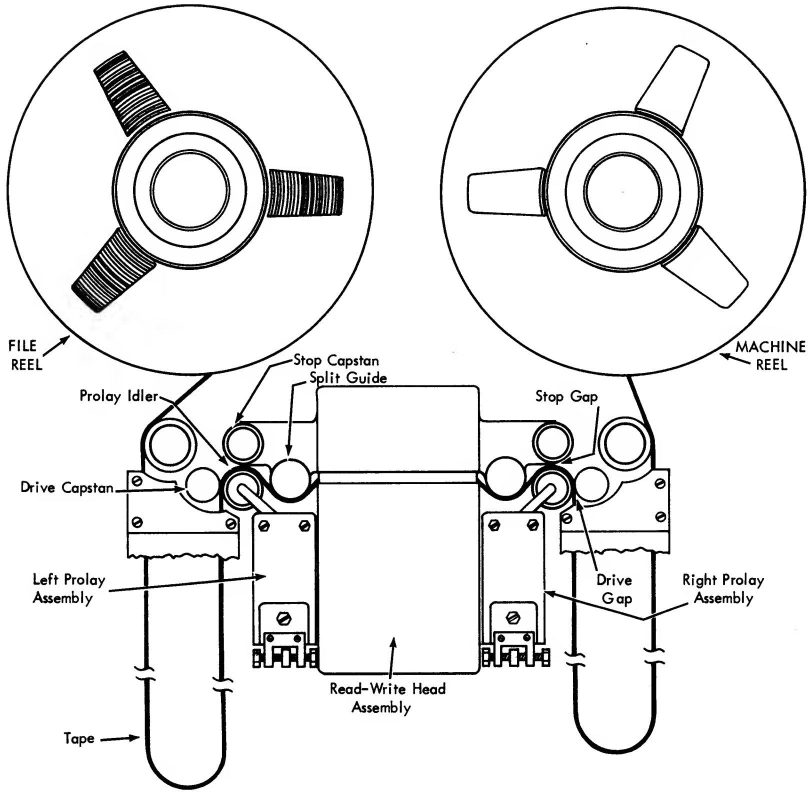


Figure 34. Path of Tape through Magnetic Tape Unit

from the capstan. Gap size becomes a function of only TAU delays plus the actual time that GO is down.

Point B occurs when GO is down for 1 to 3 ms. The actual time at which point B occurs varies with prolays. The smallest inter-record gap occurs because the prolay has time to respond by overshooting through neutral (a normal action). As a result of the overshoot, the prolay has further to travel to the capstan resulting in slower starting and a shorter gap. Some prolays overshoot through neutral farther than others. Normally, this is no problem, except when the gaps become shorter than allowable or when a program consistently utilizes this area of GO down time. This problem can be aided by lowering the neutral current from the nominal 3 amps to 2.5 amps.

Point B is the most critical point of a shimmed prolay.

Point C is also caused by the prolay overshooting through neutral toward the capstan. Point C differs from Point B in that GO is down just long enough to take advantage of the return momentum of the prolay. Thus, tape movement begins sooner and the inter-record gap is larger.

Points D and E: The area between points D and E is created by varying GO down from 10 to 100 ms. This much GO down time allows the prolay to stabilize in the neutral position; therefore, the inter-record gap should be stable.

Point F is formed by a GO down time of about 5 seconds. The inter-record gap is normally stable but can shorten because of a count-five condition.

Prolay Specifications

Prolays now contain 0.003-inch shims on each side of the main casting, providing total shimming of 0.006 inch. See Figure 40. These prolays can be identified by a marking on the bottom of the prolay casting:

Unshimmed 

Shimmed 

Shimming the prolay has essentially increased the force available to penetrate the drive capstan. The higher force overcomes count-five tendencies. (A count-five condition is a very slow acceleration, after a

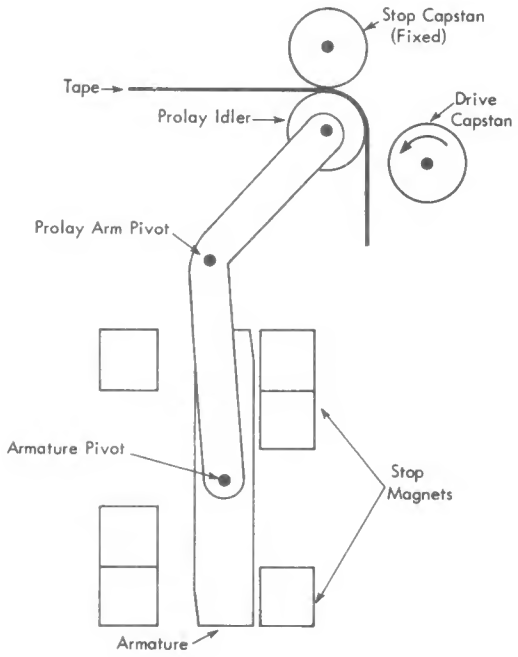


Figure 35. Right Prolay with STOP Magnets Energized

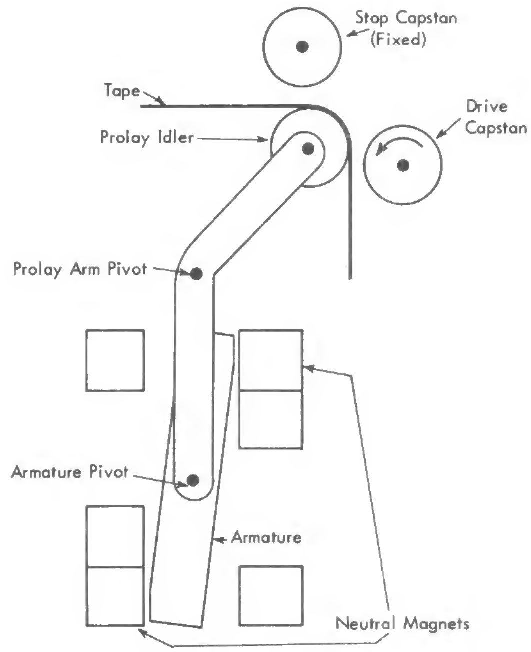


Figure 36. Right Prolay with NEUTRAL Magnets Energized

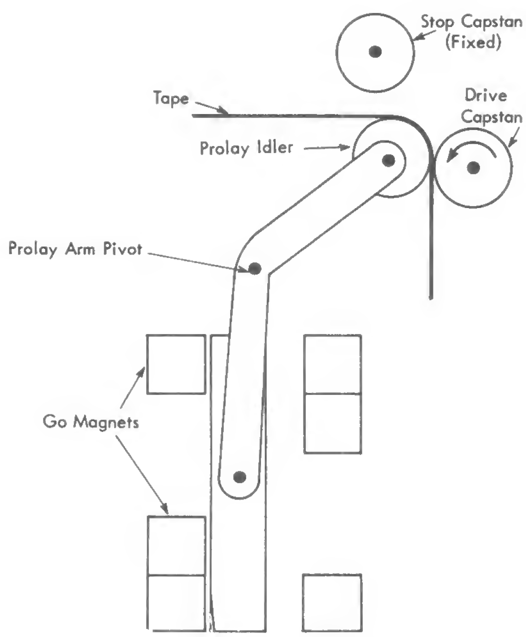


Figure 37. Right Prolay with GO Magnets Energized

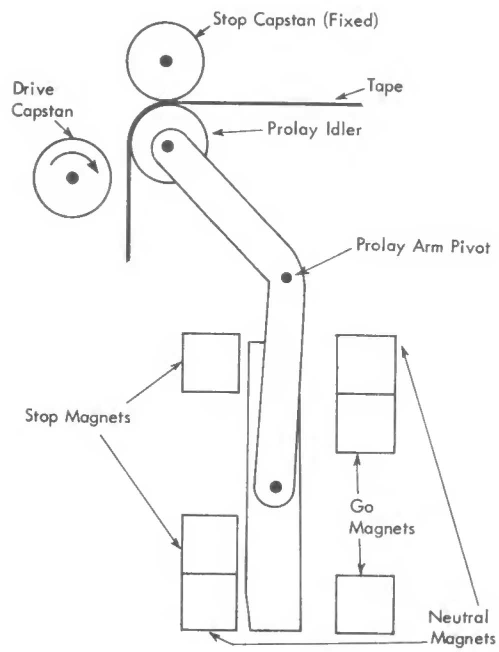


Figure 38. Left Prolay Showing Position of Magnets

5-second or longer idle period, on prolays which may otherwise indicate a good start envelope on continuous start-stop.) All prolay information now refers to these shimmed prolays.

1. Drive and stop gaps should not be less than 0.003 inch.

2. The start envelope must not drop below 95 percent full amplitude after 7 ms (729 II and V) or 5 ms (729 IV and VI). See Figure 41.

3. There should be no glitching (breaking of start envelope) of either the forward or backward start envelope.

4. Maximum noise burst following the stop envelope should not exceed five pulse cycles (ten peaks).

Prolay Servicing

Cleaning and Inspection

Check frequently for dirty or burned nylon idlers. Inspect and clean prolays whenever significant changes are indicated by inter-record gap tests or whenever customer performance indicates possible prolay trouble. If any signs of wear or corrosion are evident on fork arm pivots or armature pivots after cleaning, the entire arm assembly should be replaced. All shafts must be clean; if they cannot be cleaned, replace them. After cleaning and inspection, check prolay start-stop waveforms.

When a nylon idler, fork arm or entire prolay assembly has been replaced, check mechanical skew (1 and C tracks). If it varies from the original skew by more than 1 μs, closely inspect the new nylon idler and replace it if the surface finish appears rough. A rough surface finish of the nylon idler can also cause a complete or partial collapse of the start envelope after 100 percent amplitude has been reached, usually 5 to 7 ms after GO is brought up. This condition will cause the envelope to closely resemble an "arrowhead," and usually indicates a rough idler on the left side. See Figure 45.

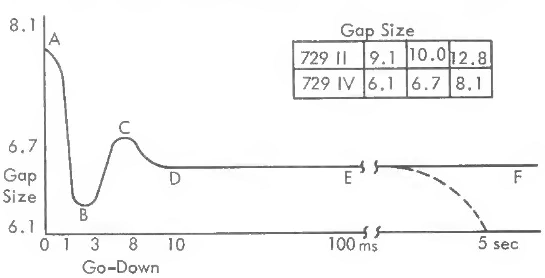


Figure 39. Graph of GO Down Time vs. Gap Size

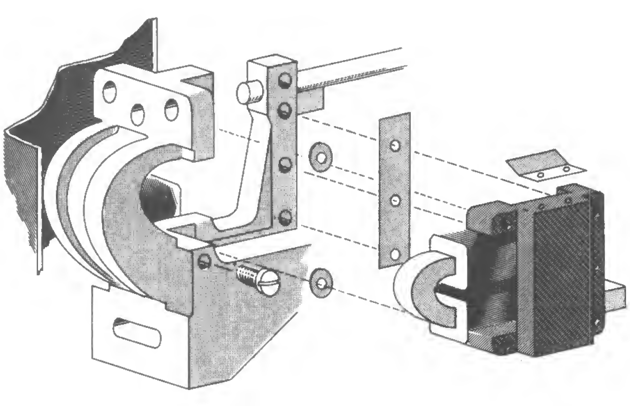


Figure 40. Shimmed Prolay

When Mylar residuals on the inside of the 729 prolays become dirty, they contribute to poor performance and should be cleaned with a cotton-tipped swab. After cleaning, inspect the prolay cavity with a light to make sure that no residue remains .

Lubrication

Apply a thin film of IBM 6 oil to the armature and to forked arm pivots. Use a small amount of IBM 4 on the nylon idler shaft, taking care not to get the lubricant on the Mylar residuals. Any prolay assemblies that are chronically troublesome, even with this type of maintenance, should be replaced.

Pre-lubricated idler pulley bushings (bronze bearings) speed up replacement of a worn pulley. String pulleys on an oiled pipe cleaner while in storage as spare parts. The bronze bushing soaks up a maximum amount of oil (IBM 6), resulting in longer bearing life. Additional oiling is not necessary on installation.

> CAUTION
>
> The pipe cleaners should be wet with oil but not saturated so that they drip. Clean the bushings carefully before slipping them onto the pipe cleaner. Store the pulleys in a plastic container to prevent the accumulation of dust and dirt. The outside diameter of the pulley should be thoroughly cleaned of all oil before installation.

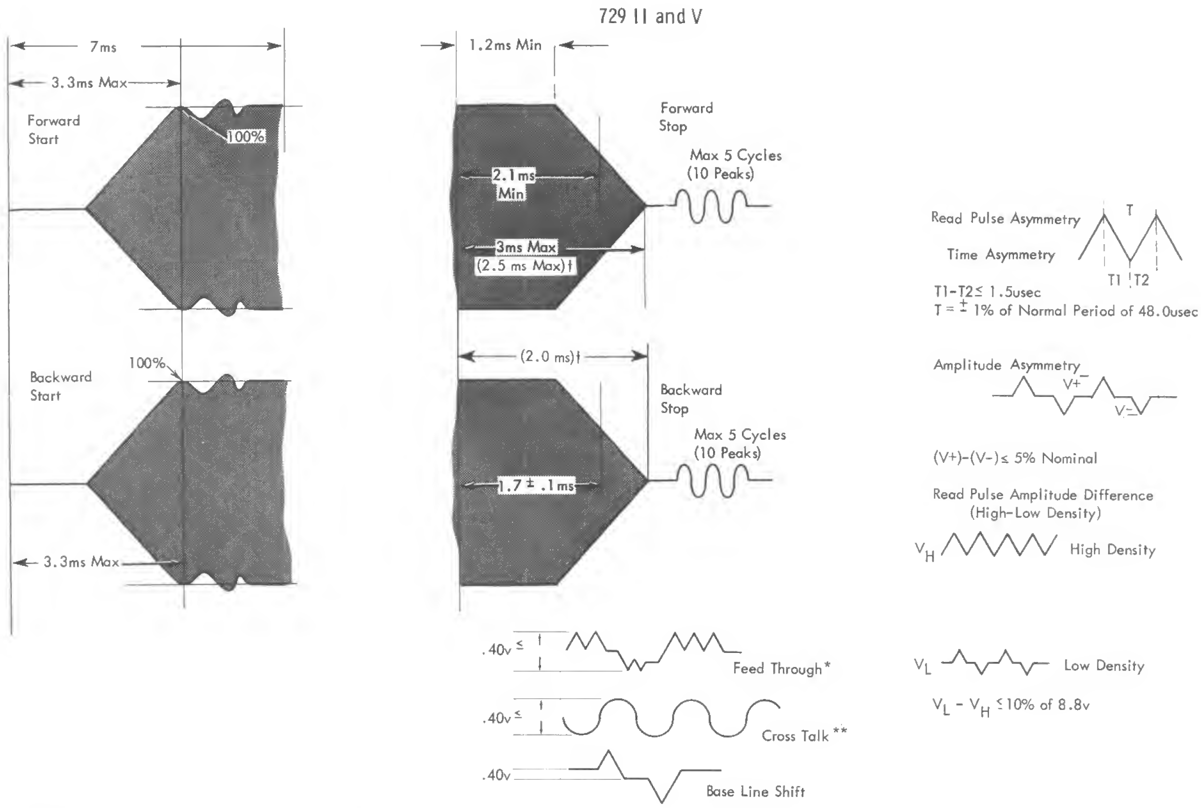
Prolay Adjustments (Figures 41 through 45)

Prerequisites to the following adjustment sequence are clean, lubricated prolays and a clean tape transport. Make prolay adjustments in this sequence: steady-state current, initial gap adjustment, dynamic gap adjustment, on-line testing. Before making prolay adjustments, mount and load a work tape, not intended for customer use. Use CE panel switches to space tape away from load point.

> CAUTION
>
> Do not use tape that is intended for system's use (customer's tape).

Steady-State Current Adjustment (Systems 9.50.3 and Figure 19): With tape unit in a static condition:

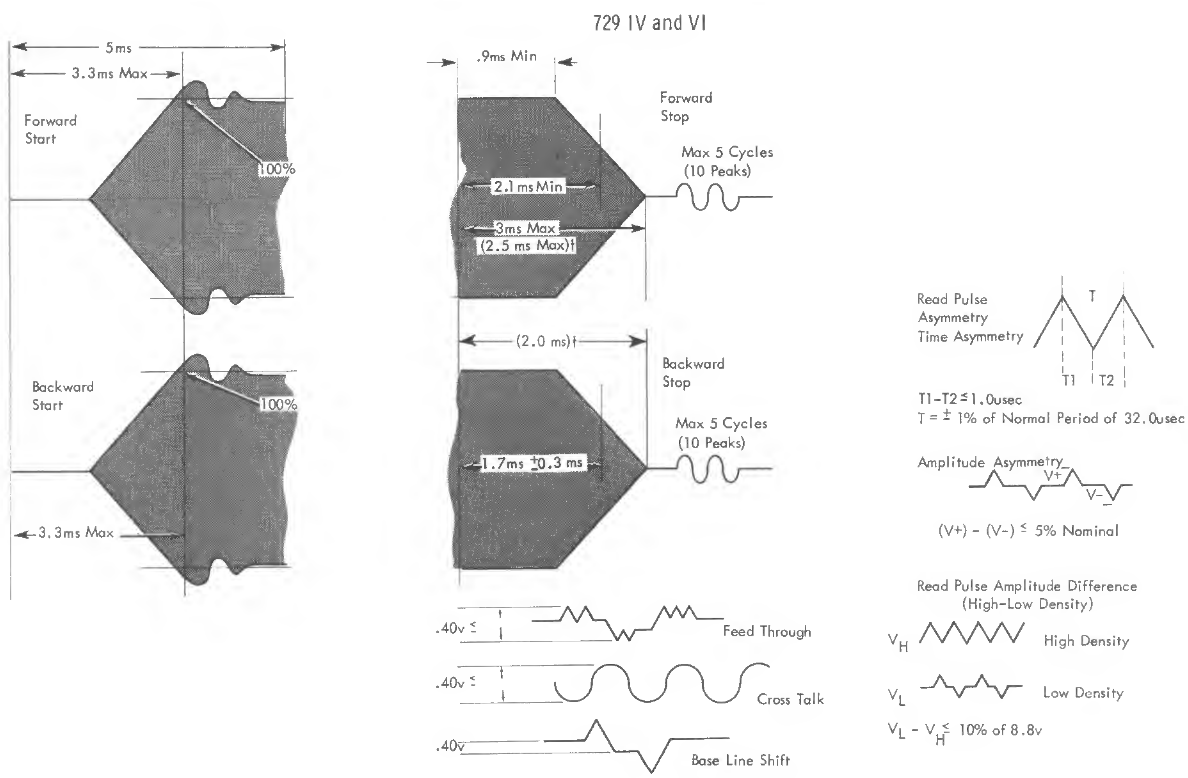
1. Set R5 (drive current adjusting pot) for a 4v drop across parallel 2-ohm resistors R3 and R4, cor-



*Feed Through - Signal picked up on the read head from write tracks while in write status

**Cross Talk - Signal picked up from adjacent read tracks, in read status

†Note: Figures in parentheses apply when using Prolay Adjustment (Alternate Procedure) described on page 49.



≥ Greater than or equal to
≤ Less than or equal to

• Figure 41. 729 II and IV Start-Stop Timings

responding to 4 amps steady-state drive current. Use test points TB11-3 and TB11-8.

2. Set R4 (neutral current adjusting pot) for a 3v drop across parallel 2-ohm resistors R1 and R2, corresponding to 3 amps steady-state neutral current. Use test points TB11-3 and TB11-7.

NOTE: Some tape units will not meet the required 4.0 amp steady-state drive current specifications. The current is limited by the wire size in the cable from the prolay control box to the logic gate. If difficulties are encountered due to this reduced current, a 10-watt, 1-ohm resistor, P/N 528454 may be added from TB11-8 to TB11-9.

CAUTION: Drive current adjustment pot should be set to minimum current before adding resistor. Voltmeter readings will become one-half of what they were prior to change. 4.0 amps of current will read 2.0 volts across network which is now one-half ohm. Do not exceed 4.3 amps.

Initial Gap Adjustment: Initial gap settings should be: drive gap 0.005 ± 0.001 inch, stop gap 0.004 ± 0.001 inch. Adjust drive and stop gaps as follows:

1. With tape unit unloaded, remove the lower head assembly decorative cover and loosen the mounting bolts (three per prolay) one-quarter turn, to allow the prolay to pivot (Figure 42).
2. Press the reel release key, and wind several extra turns of tape on the machine reel by hand.
3. Press the load-rewind key. Before the load point is sensed press the reset key.
4. Open the door and pull both capstans forward. The prolays are now in forward stop status.

CAUTION: Adjust the drive current pot for maximum resistance before making the described change. Installing the 1-ohm resistor reduces effective resistance between TB11-8 and TB11-9 to 0.5 ohms. Voltmeter readings across these points will be halved, so that 4.0 amps of drive current will read 2.0 volts. Do not exceed 4.3 amps drive current (2.15 volts deflection).

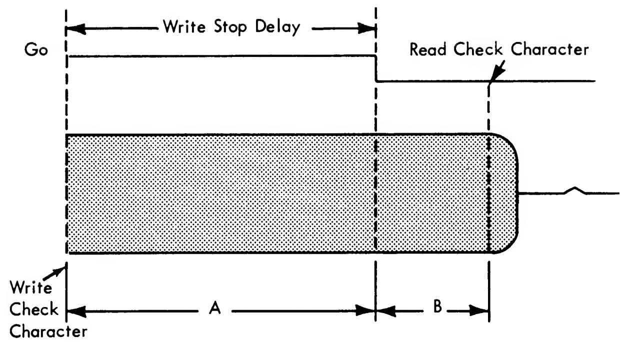
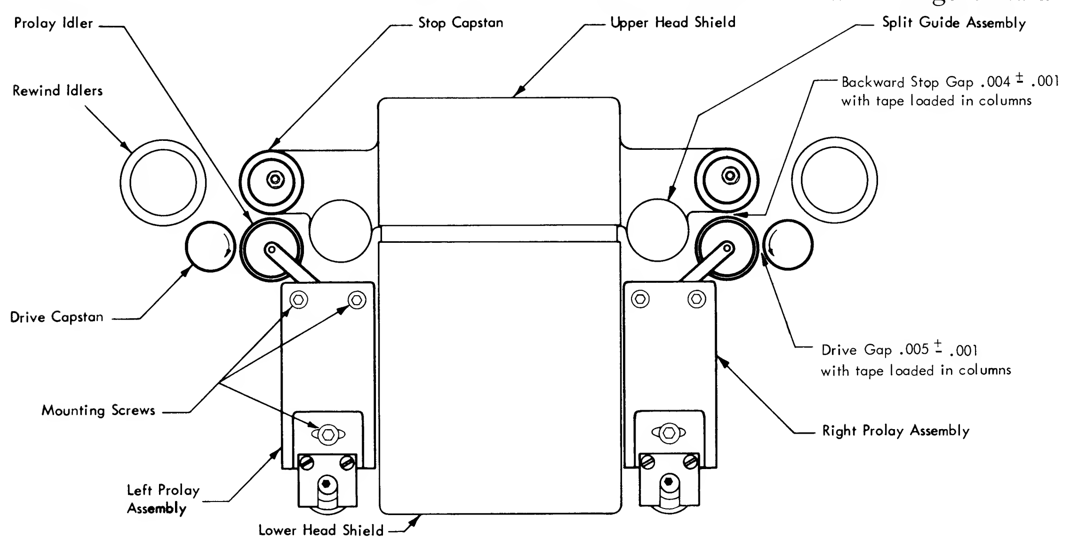


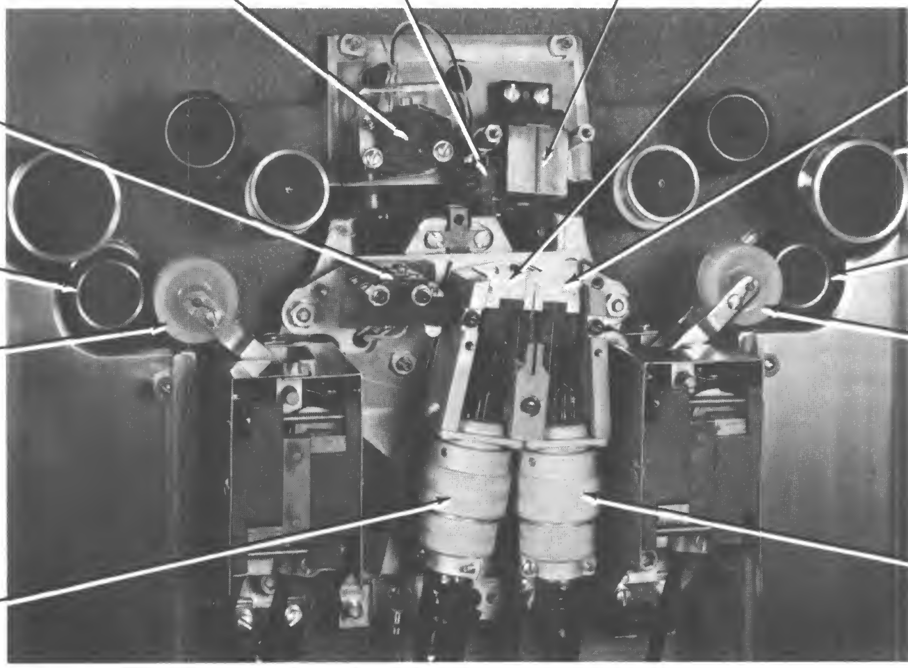
Figure 43. Stop Envelope

5. Turn the right prolay adjusting screw (Figure 44) to establish an initial drive gap of 0.005 ± 0.001 inch, measured between the drive capstan and the prolay idler.
6. Tighten the prolay mounting screws and recheck the gap.
7. Loosen the right stop capstan adjusting screw (inner screw) and rotate the stop capstan to establish an initial stop gap of 0.004 ± 0.001 inch, measured between the stop capstan and the prolay idler. Tighten the stop capstan adjusting screw and recheck the gap.
8. Push the right drive capstan to the retracted position.
9. Press the load-rewind key. The prolays are now in backward stop status.
10. Repeat steps 5 through 8 for the left prolay.

Dynamic Gap Adjustment: Using the CE test panel to move tape, scope the start-stop waveforms and adjust drive and stop gaps until waveforms are similar to those shown in Figure 41. If breaking of the start



• Figure 42. Prolay Drive and Stop Gap Adjustments



• Figure 44. Read-Write Head and Transport Assembly

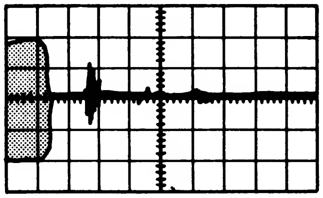
envelope (glitching) occurs, determine the cause, and adjust the start gap until the waveform is free from it (see Figure 45M). Glitching is caused by one of two conditions:

1. Too large a drive gap on the driving prolay.
2. Too small a drive gap on the non-driving prolay (this causes mechanical overshoot through neutral, allowing the prolay idler to hit the drive capstan when the non-driving prolay is switching from stop to neutral status).

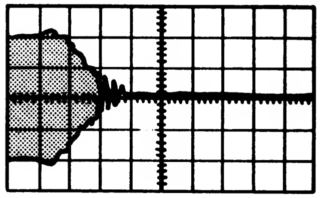
Proceed as follows when checking start-stop waveforms:

1. Mount and load a work tape, not intended for customer system's use.
2. Insert multivibrator test card in tape unit card locations C28 and D28. P/N 373305, a double card containing a variable-frequency write oscillator, should be used.
3. Connect oscilloscope as follows: sync lead to GO hub on front CE panel, "A" input to the input of the read preamplifier final stage for any track (Systems 07.00.1). Use external synchronization, 2v/cm deflection.
4. Set CE tester switches to write ones continuously on all tracks. If using test card P/N 373305, adjust write character frequency for 16 μs/character (729 II and IV), or 11 μs/character (729 V and VI).
5. Write tape continuously at the recommended frequency until tape is about ½ inch deep on the machine reel, and rewind.
6. Set CE tester switches for a read-forward start-stop operation. Using positive external synchronization and 1 ms/cm time base, check that forward start timings meet the specifications given in Figure 41. If necessary, vary the drive gap setting slightly to get waveforms with the timings shown.
7. Repeat step 6 for a read-backward operation: check the backward start waveform, and adjust the backward drive gap if necessary.
8. Switch to negative external sync (sync on fall of GO), and observe the forward-stop envelope. Adjust the forward-stop capstan to meet Figure 41 specifications. The 50 percent amplitude point of the forward-stop waveform should not occur earlier than 2.1 ms. Set the capstan for the longest possible envelope without exceeding the noise burst specification (i.e., the left stop capstan must control stopping). The stop envelope must reach zero amplitude within 3.0 ms. If inter-record gap tests indicate short gaps, the forward coast potentiometer may be used to fill in the forward stop envelope.
9. Adjust the backward stop gap to obtain the timings shown in Figure 41. Final adjustment of the backward stop capstan should be made on-line to meet tape forward creep specifications.

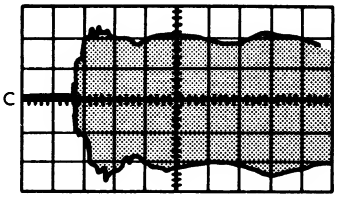
Repeat steps 3 through 10 of the initial gap adjust-

A


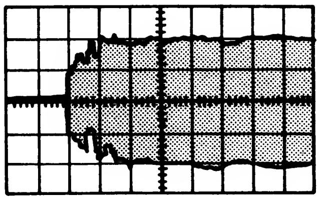
Sync: Fall of Go
Input: Read Bus
Defl: 2v/CM
Sweep: 1 MSC/CM
Prolay Stop Gap Too Small.

B


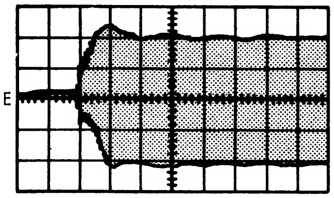
Sync: Fall of Go
Input: Read Bus
Defl: 2v/CM
Sweep: 1MSC/CM
Prolay Stop Gap Too Large.

C


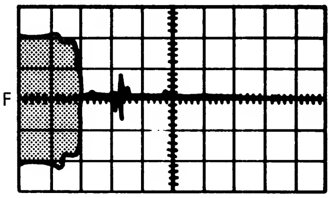
Sync: Rise of Go
Input: Read Bus
Defl: 2v/CM
Sweep: 1MSC/CM
Prolay Drive Gap Too Small.

D


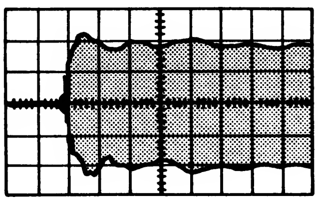
Sync: Rise of Go
Input: Read Bus
Defl: 2v/CM
Sweep: 1MSC/CM
Prolay Drive Gap Too Large.

E


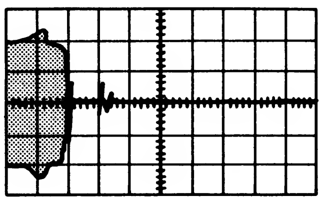
Sync: Rise of Go
Input: Read Bus
Defl: 2v/CM
Sweep: 1MSC/CM
Good Forward Start Envelope.

F


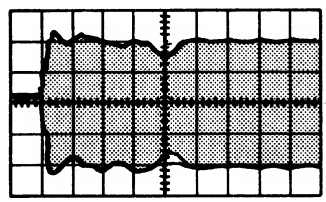
Sync: Fall of Go
Input: Read Bus
Defl: 2v/CM
Sweep: 1MSC/CM
Good Stop Envelope.

G


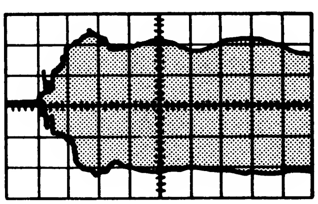
Sync: Rise of Go
Input: Read Bus
Defl: 2v/CM
Sweep: 1MSC/CM
Good Backward Start Envelope.

H


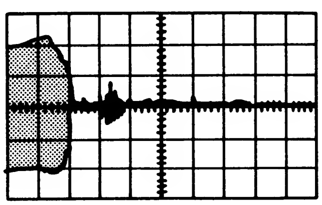
Sync: Fall of Go
Input: Read Bus
Defl: 2v/CM
Sweep: 1MSC/CM
Signal Decreases at 1.5MSC Full Coast Set Correctly.

I


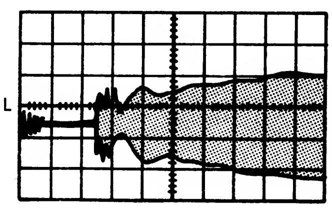
Sync: Rise of Go
Input: Read Bus
Defl: 2v/CM
Sweep: 2MSC/CM
Signal Loss 10MSC After Rise of Go.

J


Sync: Rise of Go
Input: Read Bus
Defl: 2v/CM
Sweep: 1 MSC/CM
Forward Start Set to Compensate for a Bound Prolay.

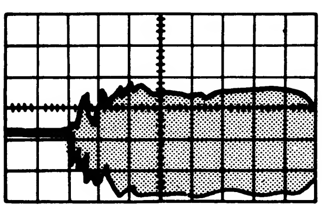
K


Sync: Fall of Go
Input: Read Bus
Defl: 2v/CM
Sweep: 1MSC/CM
Signal Up for 1.8MSC Full Coast Too Long.

L


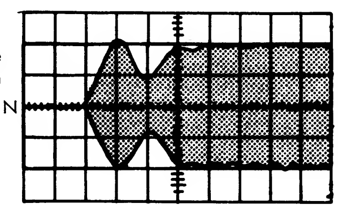
Sync: Rise of Go
Input: Read Bus
Defl: 2v/CM
Sweep: 1MSC/CM
Typical "Count Five" Start Envelope.

Sync: Rise of Go
Input: Read Bus
Defl: 2v/CM
Sweep: 1MSC/CM
Typical "Glitching" of Start Envelope.

M


Typical arrowhead start envelope caused by rough surface finish on prolay pulley

Sync: Rise of Go
Input: Read Bus
Defl: 2 v/CM
Sweep: 1 MSC/CM

N


• Figure 45. Waveforms

ment procedure if it was necessary to change any gap adjustments to obtain Figure 41 waveforms. Be sure that the drive and stop gaps are not less than 0.004 and 0.003 inch, respectively, to avoid damaging tape.

Poor start-stop waveforms are frequently caused by faulty prolay driver cards. A faulty right neutral driver may cause a late forward-go and a long, tapered backward-stop envelope if the driver is slow in cutting off, for example. Exchanging drivers with known good cards is an effective troubleshooting procedure in such cases.

Coast Potentiometer Adjustment: Check that the minimum full coast times have been met. The time required to pass a given character from the write head to the read head (about 0.3 inch) is:

729 II and V	4.0 ms
729 IV and VI	2.7 ms

The control unit holds up GO, after WRITE CHECK CHARACTER (A in Figure 43), for the following:

729 II and V	3.0 ms
729 IV and VI	2.0 ms

This delay requires that tape remain at full speed for at least 1.0 ms (729 II and V) or 0.7 ms (729 IV and VI) after the fall of GO, to insure reading every written character (B in Figure 43). Adding a 0.2 ms safety factor, obtain minimum full speed coast times of 1.2 ms (729 II and V) and 0.9 ms 729 IV and VI) by means of the coast potentiometer adjustment. Use no more full coast than absolutely necessary. The left potentiometer (viewed from behind) controls forward coast. Rotate both potentiometers clockwise to increase the amount of coast.

Check prolays for binds by making sure that the change in start time is equal to or less than 0.2 ms when varying GO down time from 10 to 100 ms.

Check for a count-five condition. This is a very slow acceleration after a 5-second or longer idle period, on prolays which may otherwise indicate a good start envelope on continuous start-stop. The initial 100 percent amplitude must not be later than 3.3 ms. By adjusting the drive gap 0.001 inch either side of the nominal 0.005-inch setting, the fastest time at which 100 percent amplitude level is reached can be obtained. This applies to both forward and backward start.

Prolay Adjustment (Alternate Procedure)

This procedure is offered to supplement existing methods with another approach to prolay servicing. It is particularly effective on tape units that have had single-ply drive capstans installed (see 729 Service Aids 154 and 284).

NOTE: Lubricate the prolays before making the following checks:

Start-Stop Adjustments:

1. Arm assembly: check each prolay arm assembly for worn pivots by grasping each prolay idler and "feeling" for lost motion while power is on. Allowable motion at this point varies between prolays, but if it exceeds 0.005 inch, the arm assembly must usually be replaced.

2. Start time:

   a. With five-second GO down time (count five), the start envelope must reach initial 100 percent amplitude (Figure 41) not later than 3.0 ms after GO is energized. Adjust the drive gap dynamically, starting with a wide gap, until this condition is met. Too small a drive gap prevents the armature from sealing, thus causing a change in speed several ms after tape is up to speed. This may not be evident while scoping, but does cause trouble when writing long records under count five timing conditions. A drive gap of 0.006 ± 0.001 inch should result in a satisfactory start envelope.

   b. Check for count five in forward start operation after manually lowering the tape loop in the left vacuum column as far as possible (worst case). Repeat for backward start with a full loop in the right column. The 100 percent amplitude point may occur as late as 3.5 ms after bringing up GO in this case.

   c. Set prolay drive and neutral current at 4 amps and 3 amps, respectively.

   d. Observe the forward start envelope while varying the GO down time between 10 ms and 2 ms. At some point in this range, the 100 percent amplitude point will move out to about 4 ms, due to mechanical overshoot of the prolay arm.

   e. Without changing the GO down setting, reduce the neutral current until the 100 percent amplitude shifts back to 3 ms. Do not set neutral current lower than 2 amps.

Making the preceding adjustments will reduce the likelihood of short inter-record gaps at low GO down times.

3. Stop time:

   a. Set coast pot(s) fully counterclockwise (no coast).

   b. Adjust forward stop (left) capstan so that the stop envelope reaches zero amplitude at 2.5 ms (the left stop capstan must stop the tape).

   c. The stop envelope amplitude must remain at 100 percent until the 1.5 ms point is reached, *but not beyond.* Use the forward coast pot to fill out the stop envelope if necessary (Figure 43). The required timing should result from a forward stop gap setting of 0.007 ± 0.001 inch. Be sure that the prolay idler is not grooved.

   d. Adjust the backward stop (right) capstan so that the stop envelope reaches zero amplitude at 2.0

ms. It should not be necessary to use the backward coast pot. The required timing should result from a backward stop gap setting of 0.005 ± 0.001 inch.

e. Make final adjustment of the backward stop capstan on-line to meet tape motion diagnostic creep specifications.

NOTE: Do not adjust the backward stop capstan so that the backward stop gap is less than 0.003 inch.

f. Once they have been set by the preceding method, the setting of the forward-stop gap and the two drive gaps should not be disturbed to obtain good tape motion diagnostic printouts. Investigate and correct the true cause of error indications.

Tape Motion Diagnostics—705-III, 7070, 7090, and 1401 Tape Systems Inter-Record Gaps:

1. The shortest inter-record gap generated for any setting of GO down should be not less than 9.5 ms for 729 II and 6.4 ms for 729 IV. (The ability to meet these requirements, which are tighter than engineering specifications, will insure reliable operation when the tape unit is installed on-line.)

2. The variable-delay range should not exceed 2.0 ms (1-5 vari-delay 7T03). All other ranges should be $\leqq$ 1.0 ms, and should not exceed the 10 ms GO down range by more than 0.3 ms.

3. Average forward creep should be 2.0 ± 0.5 ms for 729 II, and 1.4 ± 0.4 ms for 729 IV. Investigate the cause of printouts indicating backward creep operations: such printouts should not be ignored.

Cleaning:

1. When investigating customer-reported tape errors, do not clean the tape transport before running tape motion diagnostics. A tape unit that meets specifications only after cleaning will probably give trouble later.

2. Some installations retain copies of printouts from tape motion diagnostics as a record of SM activity. In this case, running diagnostics on cleaned tape drives insures that printouts are generated under similar operating conditions during successive weeks.

3. If printouts indicate trouble in the tape transport area, or show marginal operation after cleaning, correct the trouble by adjustment or replacement. Cleaning the transport may temporarily overcome the difficulty; however, this is not a permanent fix for the trouble.

Removal of Arm Assembly

To remove an arm assembly from a prolay (Figure 46) when the prolay is mounted on a tape unit:

1. Make sure that the head assembly is up and that all power is removed from the prolay (drive and neutral plugs pulled, or power off on machine). This prevents magnetic attraction between the pole pieces and armature.

2. Remove the head assembly lower covers.

3. Remove the front cover of the prolay so that the main pivot shaft is exposed.

4. Loosen the setscrew holding the main pivot shaft.

5. Withdraw the main pivot shaft by gripping the protruding knurled portion.

6. Withdraw the fork arm and armature assembly. Whenever an arm assembly is removed for lubrication or inspection, the top of the armature should be marked for reference. To make certain that the armature is properly oriented when reinstalling the arm assembly, the reference mark must remain on top. In some cases, turning the armature 180° (reversing it on its shaft) will significantly alter prolay operating characteristics. This reversal could cause a count five condition.

CAUTION

When removing, and particularly when replacing, fork arm assemblies, take extreme care not to damage the Mylar shims on the pole faces. Some pole face assemblies may be fitted with Mylar shims that have the cut-out portion (used with the earlier type "humped" armature). In these cases, be sure that the armature does not damage this cut-out portion. Turned, warped, or distorted shims will cause prolay malfunctions.

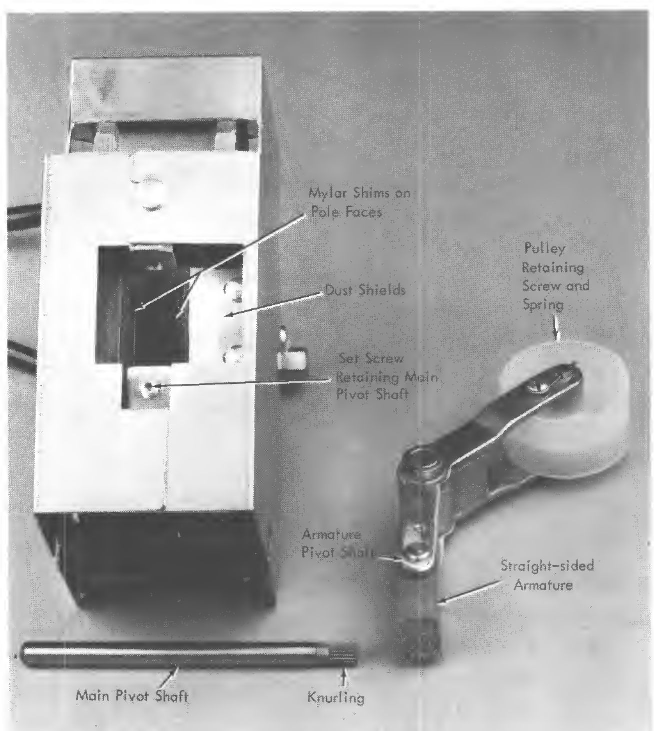


Figure 46. Removable Arm Prolay

Replacement of Arm Assembly

Replacement of the removable fork arm is the reverse of the removal procedure, but make certain of the following points:

1. Armature bevels line up with neutral pole pieces (upper right and lower left). See Figure 47.
2. Retaining wire screw for armature is toward the rear.
3. Retaining wire screw for nylon pulley is toward the front.
4. No binds in armature and fork arm.
5. No burns (nylon pulley).
6. No burrs (armature).

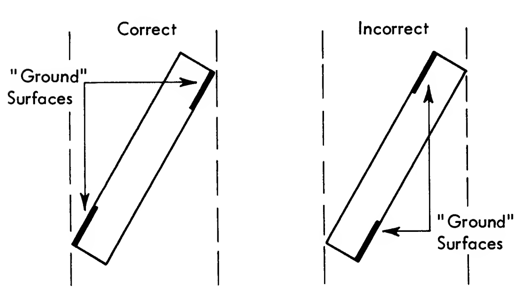
Removal of Complete Prolay

1. Drop power on tape unit.
2. Remove lower head decorative cover.
3. Disconnect two Jones plugs (stop-go and neutral).
4. Using standard cover T wrench, remove three mounting bolts.
5. Remove prolay.

Disassembly of Complete Prolay

Things to watch:

1. Mark the armature when removing it to be sure that it is installed in the same way.
2. Mark nylon idler casting when disassembling. Reverse assembly may contribute to skew.
3. Make sure that end play in the nylon idler is 0.001 to 0.003 inch. If not, stone the bearing surface.
4. Make sure that there is 0.001 to 0.003 inch end play in the prolay arm assembly. If not, stone the bearing end and deburr.
5. There is a difference between stop and go coils. There is a 0.005 inch shim over the stop coil in addition to a 0.002 inch shim.
6. Make sure that the felt pads are not binding the arm movement. A small amount of grease may help the seal.
7. Watch for soft nylon idlers. They quickly become egg-shaped. A soft nylon idler compresses easily with your fingers.



• Figure 47. Prolay Armature, Reassembly

8. Mylar shims develop air pockets. Break shims loose and re-glue.
9. Mylar shims can be replaced. Be careful to glue only at the ends and at the center of the bakelite cutout.

Binding prolays can cause erratic tape motion that is very difficult to diagnose and isolate. This condition is seldom perceptible by feel without disassembling the prolay. Binds can cause split characters, record length checks, missing records, skew, or unreadable records.

The binding may occur at either the forked arm pivot or the armature pivot. Erratic tape motion may also be aggravated by the full coast potentiometer or the positioning of the prolay or the stop capstan.

To disassemble the prolay:

1. Remove side shields.
2. Loosen two screws on neutral pole piece clamps.
3. Remove clamp and neutral coils.
4. Remove five screws holding GO and STOP magnets.
5. Remove fork arm pivot pin.
6. Remove magnets and arm assembly.
7. Remove armature pin.

Reassembly of Complete Prolay

Reassembly procedures are the reverse of disassembly, except:

1. The assembled prolay should have 0.001 to 0.003 inch nylon idler end play.
2. All pivots must be free from binds.
3. Be sure that the laminated bar connecting the neutral pole pieces is replaced with the rivets facing outward, so that the flux will flow through the laminations and not across them.
4. Make certain that the two beveled corners of the armature go to the neutral pole piece. See Figure 47.
5. Make sure that residuals are clean and free from oil; residuals must not be torn or loose and must lie flat across the pole pieces.
6. Be sure that star-shaped Mylar shields are not binding.
7. Make certain that the two felt dust guards are not interfering with the arm travel.
8. Be sure that the covers are not binding on the arm.
9. Check that the 0.005 inch shim is in the proper place: lower right corner for right prolay; upper left corner for left prolay. To change a prolay from one side to the other, rotate the magnet assembly 180° and reposition the dust wicks.
10. Be sure that the armature clip retaining screw is to the rear of the prolay.
11. Position the cable clamp so that it does not touch the magnet bar.
12. Clean facings on the prolays and machine.

Replacement of Complete Prolay

Replace the prolay assembly on the tape unit as follows:

1. When installing prolay, turn stop capstan to low dwell.
2. Mount prolay with pivot pin in pivot bushing.
3. Insert three mounting bolts, after checking that the prolay is seated against the mounting surfaces.
4. Connect the Jones plugs. Check that the left prolay neutral plug and cable are routed to the left of the access door stop. This will avoid interference with the spring rod when the door is closed.

Short Inter-Record Gaps at Low GO Down Times

All prolays now in use contain 0.003 inch shims at each side of the main casting, making a total shimming of 0.006 inch. See Figure 40.

Shimming the prolay has essentially increased the force available to penetrate the drive capstan. This higher force overcomes count five tendencies.

Using shimmed prolays, short inter-record gaps become more prominent at the critical low GO down times, between 2.0 ms and 3.0 ms. At these low GO down times the right prolay is signaled to GO just as it is reaching maximum acceleration away from the drive capstan, as a result of the previous stop signal about 2.5 ms earlier. This condition is aggravated on a shimmed prolay, because the nylon pulley is "thrown" away from the drive capstan by means of its previous deeper penetration into the capstan rubber surface.

Inter-record gap tests will show that machines with shimmed prolays produce shorter gaps in the low GO down time range. On the 729 IV and VI, the inter-record gap is likely to fall below the 6.1 ms specification. If this occurs, reducing the neutral current to 2.5 amps or 2 amps may help when the gaps remain consistently short.

Stop Capstans

The 729 read-write head assemblies now have a stop capstan that is adjustable so that all 360° of the rubber surface can be used. The capstan has two adjustments:

1. The ¼-inch adjusting screw tightens the outer shell to the main body. By loosening it, the outer shell may be rotated so that any portion of the 360° can be used as the stopping surface.
2. The ⅛-inch adjusting screw allows the entire capstan to turn on an eccentric to adjust the stop waveform.

Make sure that all parts are tight after adjustments.

Visual Inspection and Operational Check

Check stopping area for cracks in rubber or worn flat surfaces. Imperfect surfaces cause irregularities in start and stop times and may cause skew problems.

Left and right stop capstans can be interchanged if worn.

Cleaning

Clean the stop capstan where the nylon pulley contacts it. Use the cleaning applicator moistened with IBM Tape Developer and a Tape Transport Cleaner, P/N 517960.

CAUTION

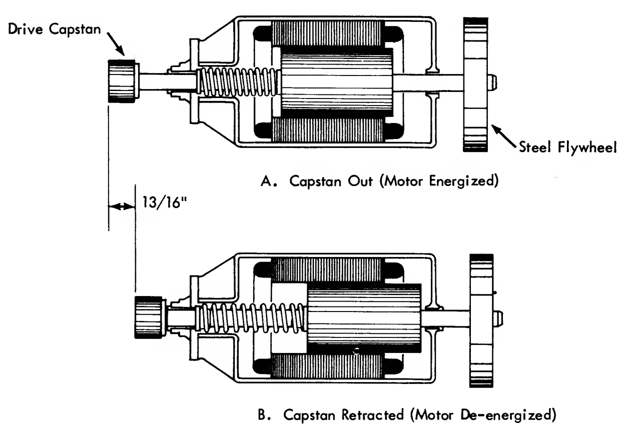
Do not allow the tape transport cleaner to come in contact with the magnetic tape.

Drive Capstans and Motors

Each drive capstan is mounted on the shaft of a reluctance synchronous motor (1/20-HP, 60-cycle, three-phase, 208 volt). See Figure 48. Each motor has a retractable rotor that provides a type of solenoid action to extend the capstan when the field is energized. When the field is de-energized, the capstan is retracted by a light spring (on the shaft) that exerts pressure on the turning rotor. This spring does not overcome the friction of the shaft when the capstan is not turning.

Position of the capstan is determined by two microswitches located on the rear of the capstan motor. Attached to the operating arm of each microswitch is a magnet that is attracted to a steel disk mounted on the rotor shaft as shown in Figure 49. This disk operates the sensing switches and acts as a flywheel for smooth operation.

When the capstan is extended, the steel disk is in the position shown by the solid lines in Figure 49. The capstan-out switch arm is attracted toward the disk and the switch is operated. When the capstan is retracted, the disk is in the position shown by the dashed lines and the capstan-in switch is operated. The switch operating arms are adjusted so that the magnets are about 0.020 inch from the disk in attracted position.



• Figure 48. Capstan Drive Motor

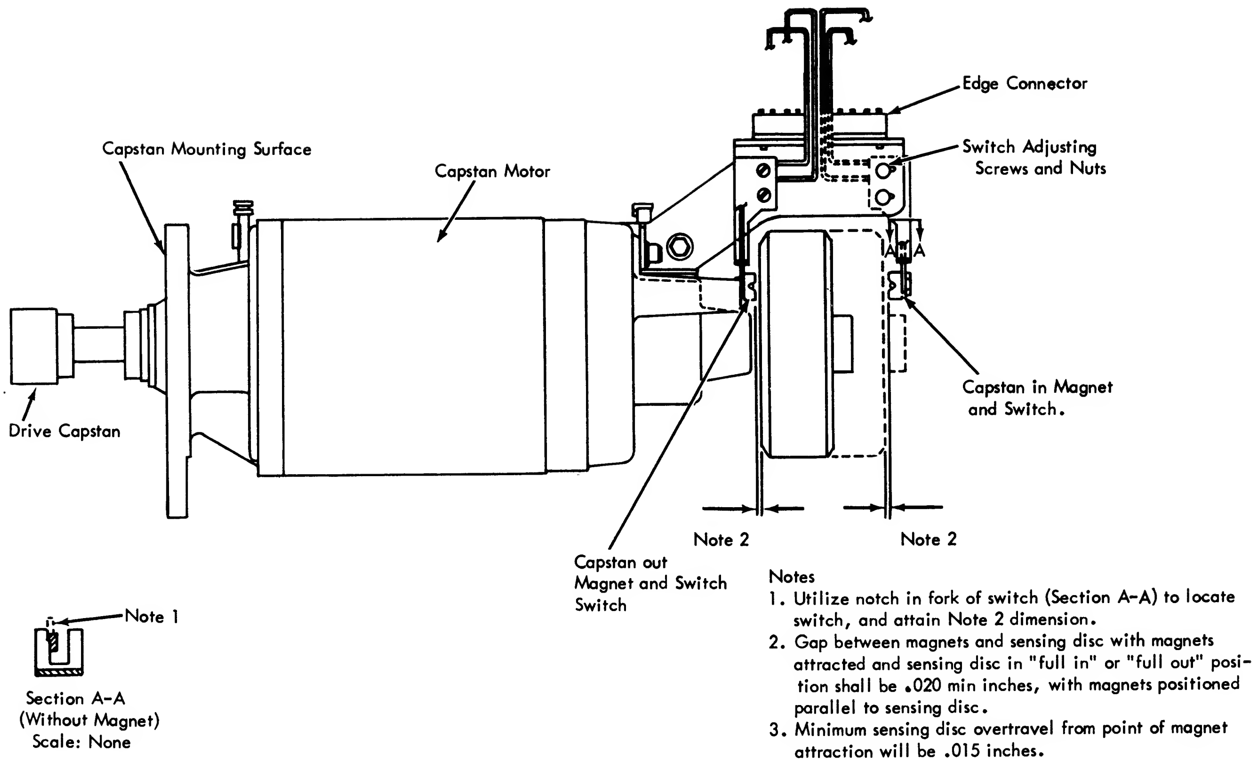


Figure 49. Capstan Motor Assembly

Visual Inspection and Operational Check

Inspect the drive shaft for dirt, chips, ridges, and binds. Sloppy bearings can usually be detected by feeling the capstans for vibration. Worn bearings will cause poor start-stop, break-up in start envelope, and variation or modulation of read signal.

All motors turn in the same direction when input power is phased 1, 2, 3. Phasing is reversed for one motor in the AC raceway. The arrow showing rotation is for factory inspection only. When in the machine, one motor will turn in a direction opposite to the arrow.

Cleaning

Clean the drive capstan surface and surrounding area with a cleaning applicator moistened with IBM Tape Developer and Transport Cleaner, P/N 517960. In extreme cases the oxide build-up cannot be removed by tape transport cleaner. In these cases, the drive capstan can be cleaned by the judicious use of IBM cleaner, P/N 450608. Make certain to keep this cleaner away from the tape.

DANGER

Do not clean the drive capstan while it is rotating under power. The drive capstan must be rotated manually while cleaning.

Lubrication

Lubricate the capstan motors with IBM 6 oil. Never allow oil to come in contact with the rubber capstan drive surface. For the front bearing (capstan end), proceed as follows:

1. Lubricate the shaft directly with one or two drops of oil on the end of a finger. Do not over-oil.
2. Move the shaft back and forth to move it into bearings. Make sure that the shaft is clean and not over-lubricated. This procedure will permit a lubrication frequency of two to three months.

For the rear bearing, use two to three drops in the oil tube every three months.

Removal and Replacement

Drive capstan motors are mounted on the reverse side of the main casting and access is provided through the rear main panel gate. To remove the motor:

1. Turn power off.
2. Disconnect the motor cables and limit switch wires.
3. Remove three 7/16-inch hex-head mounting screws.
4. Twist motor slightly and pull it out.

Replacement procedures are the reverse of removal procedures.

CAUTION

When replacing capstan drive motors, use care to seat the motor properly against the base casting.

Facing the rear of the tape unit, rotate the left motor clockwise to lock and the right motor counterclockwise to lock. Misalignment can result if the motor is turned in the wrong direction.

Replaceable Capstan, P/N 554148

Installation Procedure: Installing the new capstan requires three basic steps: removing the old capstan, drilling the new hole in the motor shaft, and mounting the new capstan. Tools required are: an electric drill or drill press, a #30 drill, and a high-speed taper reamer (P/N 461261). To remove the old capstan:

1. Remove the motor from the tape unit.
2. Using a punch, knock out the taper pin that holds the capstan on the shaft.
3. Place reamer in taper pin hole. Mark depth to which reamer can be inserted.
4. Remove the old capstan.

To drill the new hole in the motor shaft:

1. Place the new capstan on the shaft.
2. Screw the set screw into the larger diameter of the existing hole through the shaft. This locates the position of the new capstan and holds it tight on the shaft for the drilling operation.
3. Using the #30-inch drill, drill through the shaft using the pilot hole as a starter. Be careful; the drill tends to walk when starting into the opposite side of the old hole. Use little or no oil while drilling to protect capstan rubber. Wrap a cloth around the shaft so that chips cannot get on to the shaft and into the bearings. Try not to break the drill; keep the hole as straight as possible.
4. Ream the hole to the depth marked on the reamer from the old hole.
5. Clean the hole of any burrs, chips, and oil.

To mount the new capstan:

1. Drive the new taper pin into the hole until a good tight fit is obtained. The large end of the pin should be about flush with the capstan.
2. DO NOT remove the set screw. The set screw retains any foreign matter caught inside.
3. Remount the motor on the tape unit.

CAUTION: Support motor shaft while driving taper pins and drilling the hole to avoid bending the shaft or damaging bearings. Do not attempt to replace capstan with motor mounted in the tape unit.

Visual Inspection and Operational Check

Check operation of the capstan limit switches periodically with an ohmmeter while pushing the capstans in and out manually. Replace any switch having contact resistance or "noisy" make. An indicated "short" may be due to buildup of powdered iron on the switch connectors, rather than a short in the switch itself.

Adjustment, Capstan-In and Capstan-Out Switches

Remove all power from the tape unit and push the capstan motor shaft to both the in and out extreme positions. An audible sound can be heard when these switches operate. If either or both switches do not operate:

1. Check clearance on the fork assembly. If clearance is inadequate, spread the assembly with a screwdriver.
2. Loosen the appropriate switch, move lug screws, and alter their physical position as required. (Figure 49).

Vacuum System

Vacuum Columns (Figure 17)

The vacuum columns act as a storage area for the tape, allowing the tape to be moved across the head, at random, without having to turn the reels simultaneously. They also exert tension on the tape, preventing tape buckle at the head during starting and stopping.

The columns are rectangular with inside dimensions of 2.5 inches × 0.510 (+0.002, −0.000) inch. The transparent front of the column is hinged so it can be opened to permit easy cleaning. The top of the column is open; the lower end is connected to a manifold leading to a vacuum system that maintains a vacuum with tape in the column. Tape hangs in the column so that only the sides of the semi-circular loop touch the sides of the column. Vacuum is maintained below the tape loop in the column, while atmospheric pressure exists above the loop.

Visual Inspection and Operational Check

Check the manifold mounting screws for tightness. Loose manifolds cause vacuum leaks. Check, for cracks or looseness, the plastic tubes connecting the vacuum switches to the vacuum column take-off ports.

Cleaning

Clean inside surfaces with a cleaning applicator and approved cleaning fluid. Remove all bits of tape and other dirt from the screen at the bottom of the columns.

Lubrication

Apply IBM 17 lubricant to the vacuum column door latches.

> CAUTION
>
> Do not lubricate any other part of the vacuum columns except the door latches. Lubricant in any other area will contaminate the tape.

Vacuum Column Switches (Diaphragm Switches)

Each column contains two holes: one about one-third of the column length from the top; the other about one-third of the column length from the bottom. A vacuum-operated switch is attached, by a short tube, to each hole. As the tape loop is moved past the holes, the change in air pressure is sensed by the switch. The

vacuum column switch is shown in Figure 50. The presence of a vacuum causes the diaphragm to move in a direction to transfer the contacts of the switch. For greater reliability, two sets of contacts are used in parallel.

Visual Inspection and Operational Check

Inspect vacuum column switches for dirty, pitted, or misaligned contacts, or loose diaphragm nuts and mounting screws. Look for cracked or damaged diaphragms, and dirt or foreign particles. Inspect the R/C network for broken wires, or burning of the resistor or insulating cover.

Check the tape unit for load, unload, and rewind operations. Excessive tape breakage during these operations may be due to defective or maladjusted vacuum column switches.

To check the switch operation, simulate tape loading without tape to bring up the vacuum. Connect a short piece of tape (15 inches) to the outside of the column and alternately lower and raise this tape into the column. Observe the action of each vacuum column switch.

Adjustment, Vacuum Column Switch

Push Rod: The vacuum switch push rod should have 1/64-inch clearance between the adjusting nuts and the switch transferring contact strap. Position the adjusting nuts as required to attain this condition (Figure 50).

An R/C network, consisting of a 5 mfd, 250v capacitor and a 30-ohm, ½-watt resistor is connected across each set of vacuum column switch contacts for noise suppression. If burning of the resistor occurs, replace it with a 30-ohm, 1-watt resistor, P/N 509507.

Tape-in-Column Switches

A number of logic functions of the tape unit require that the presence of tape in the columns be sensed. This is accomplished by pressure sensitive switches called tape-in-column switches. One switch is mounted at the bottom rear of each vacuum column and is connected to the vacuum column by plastic tubing.

The tape-in-column switches are similar to the vacuum column switches, but use a different spring. They operate as follows: When tape is out of the columns, the normally closed switch contacts are closed. When tape enters the columns, the flow of air in the columns is restricted and a partial vacuum is created, causing the tape-in-column switches to operate.

Vacuum-Off Bellows Switch

A bellows-type vacuum switch allows machine operation only if vacuum is maintained above a certain level. Lack of safe operating vacuum removes power from the tape unit run relays (R1 and R2). This bellows switch (vacuum safety switch) is mounted on the manifold between the vacuum columns (Figure 51).

When vacuum builds up within the manifold, the bellows contracts and the microswitch transfers, indicating that vacuum has reached the required level.

Cleaning

Remove dirt, dust, and foreign particles from the general area with a vacuum cleaner and a dry, lint-free cloth as required.

Adjustment

Adjust the vacuum safety switch as follows:

1. Open tape unit front door and access door (between vacuum columns).

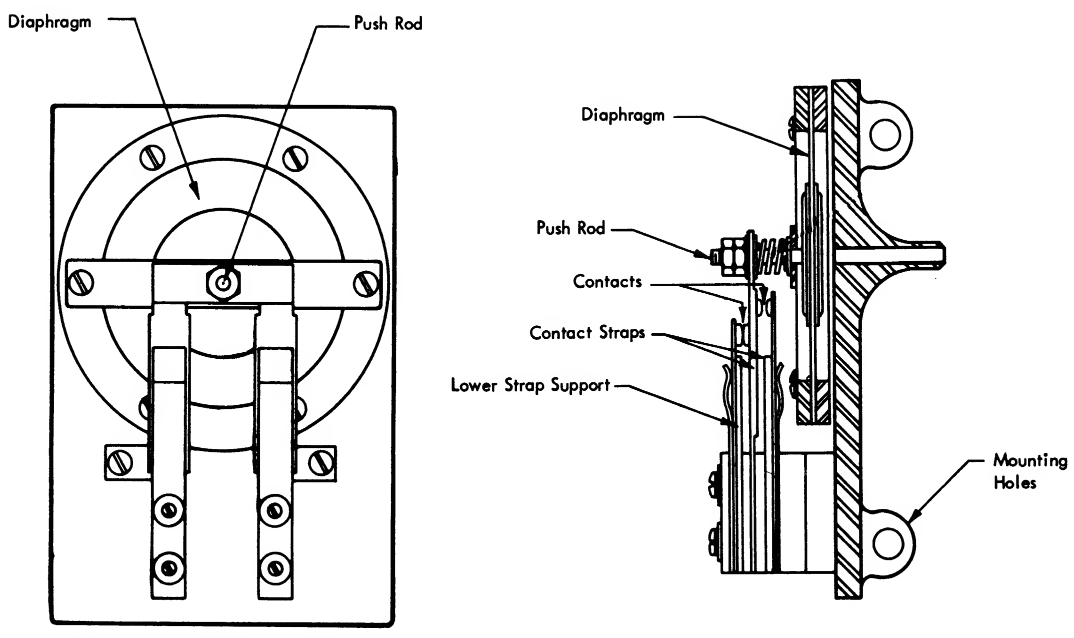


Figure 50. Vacuum Column Switch

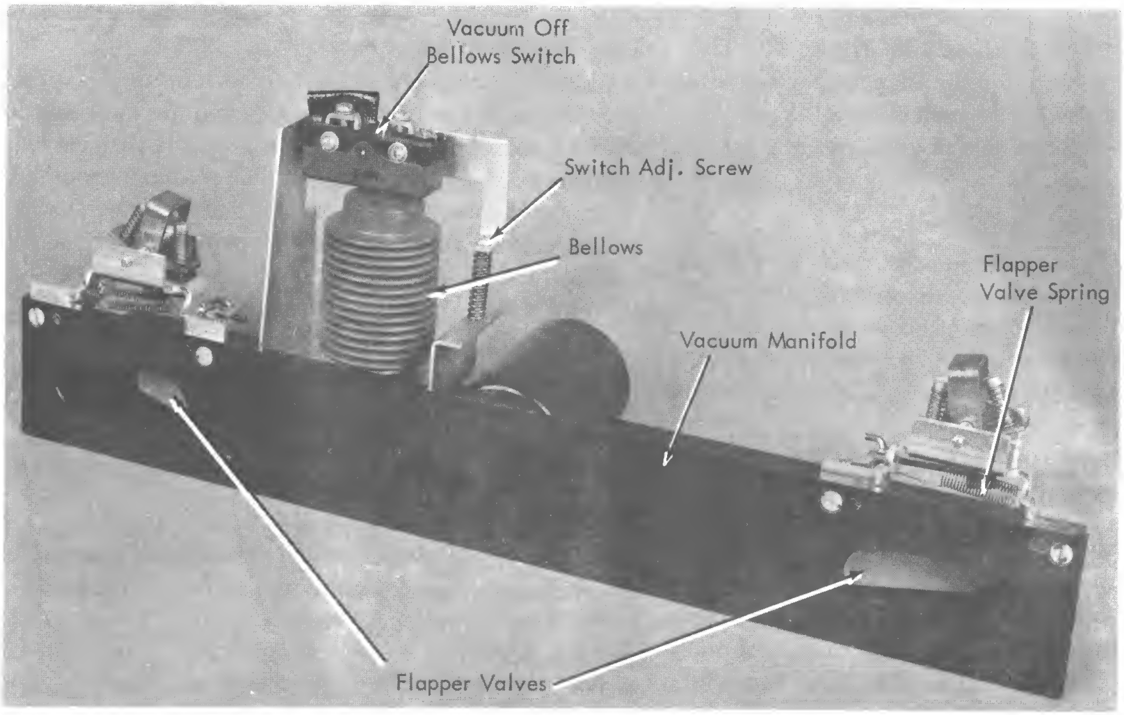


Figure 51. Vacuum Manifold Assembly

2. Unload and remove magnetic tape from machine.

3. Actuate the door interlock switch and press LOAD REWIND. (Since no tape enters the columns, the reel hubs will turn continuously.)

4. Turn the switch adjusting screw (Figure 51) *clockwise* until the reels stop turning.

5. Turn the adjusting screw *counterclockwise* until the reels start turning, plus an additional quarter turn.

Flapper Valves

Flapper valves located at the bottom of each vacuum column are no longer used, and should be blocked open by turning the outer adjusting screw all the way in (clockwise). See EC 252528, CEM 93. Recheck adjustment of the vacuum-off bellows switch after the flapper valves have been blocked open.

Reel Drive Assemblies

Two continuously-running motors, turning in opposite directions, are the source of forward and backward tape reel motion. This motion is transmitted to the tape reel shafts by energizing the appropriate reel drive clutches (left up, left down, right up, right down). Reel motion is stopped by energizing the appropriate stop clutch (right or left). Each tape reel shaft has an up, down, and stop clutch mounted on it; the stop clutch is toward the front of the tape unit (Figure 52).

Reel Drive Motors and Belts

The "forward" reel drive motor is coupled to the center clutch on each shaft (left down and right up) by a pair of V-belts .The "backward" reel drive motor drives the rear clutches (right down and left up) through a second pair of belts. Both motors are rated ¼ hp, 208v, 1140 rpm.

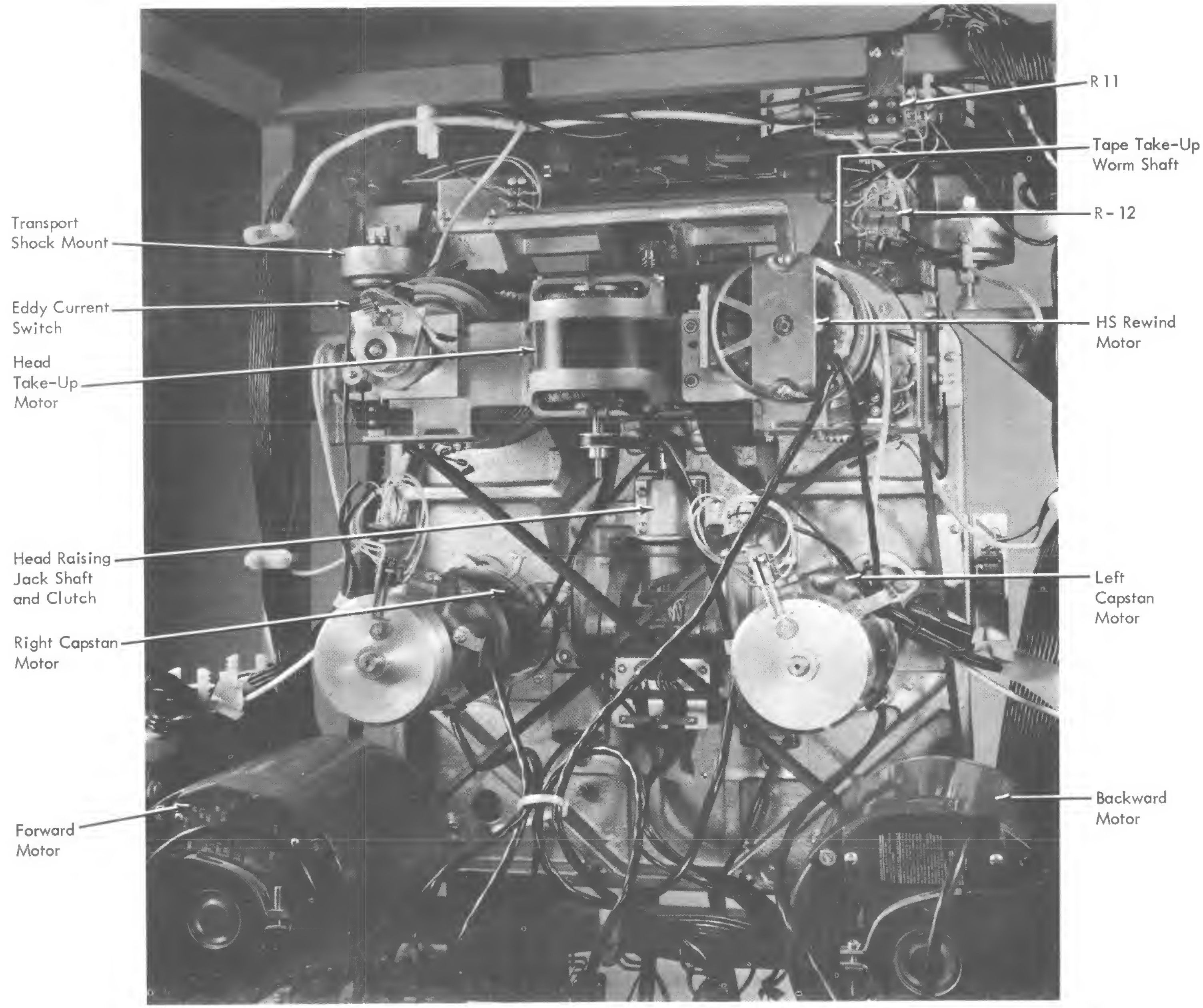
Replacement reel drive belts are supplied in matched pairs. Replace both when either becomes worn or damaged.

> CAUTION
>
> Use extreme care when working inside the tape unit to avoid injury from the reel drive motors and belts. Whenever possible, the motors should be unplugged as a safety precaution.

Reel Drive Clutches

Each tape reel is mounted on a hub protruding from the upper front of the tape unit. This hub contains a rubber rim that grips the reel tightly when the knob in the center of the hub is tightened.

The hub is on a shaft controlled by three magnetic powder clutches: one for forward motion, one for reverse motion, and one for a brake. The innermost part of the magnetic clutch (Figure 53) is a rotor keyed to the reel shaft. Surrounding the rotor is the clutch



• Figure 52. Drive Mechanisms

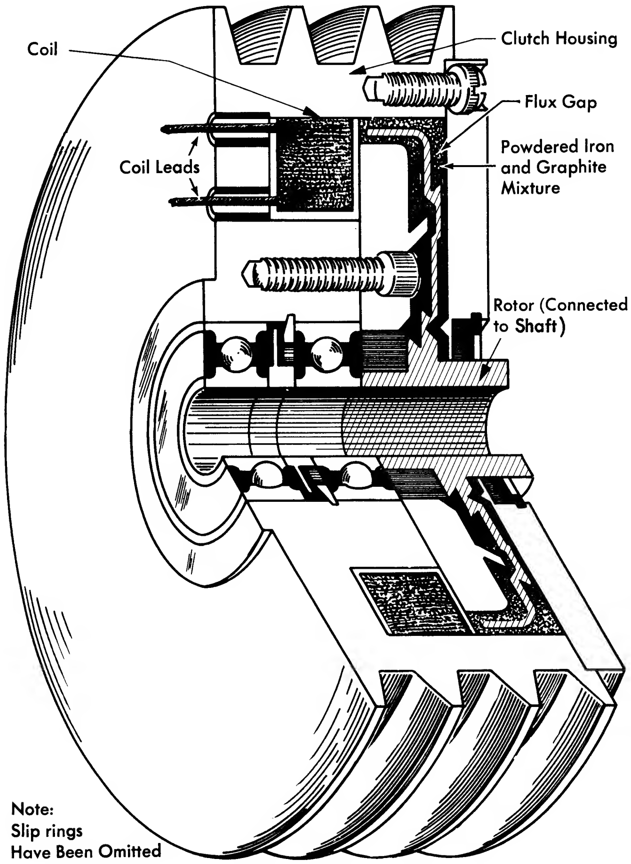


Figure 53. Magnetic Clutch

housing, which is mounted on sealed bearings and is free to turn on the shaft. Embedded in each clutch housing is a coil that is connected to concentric slip rings on one housing surface.

The outside of each up and down clutch housing is a three-groove pulley that carries the reel drive belts. Stop clutch housings are worm gear driven during a load-unload operation; their housings are held stationary once the tape unit is loaded.

Between the rotor and the housing is a mixture of iron powder and graphite. When current flows through the coil, flux is produced. The flux solidifies the iron and graphite mixture and causes the rotor and housing to be essentially locked together. Although the housing turns continuously through pulley action, the rotor does not move with it unless current is flowing through the coil. As current flows through the coil, the rotor begins to move with the housing, turning the hub and reel at the front of the machine.

Because of the gradual build-up of current in the coil (due to inductance), the torque transmitted is proportional to the current, producing a smooth acceleration. This smooth acceleration prevents tape breakage by not shocking the tape into motion. The magnetic powder clutch was selected for its ability to produce smooth acceleration and large torque with small control current. To hold the iron-graphite mixture in the flux gap, ridges are designed into the clutch parts. These ridges assist centrifugal force to keep the powder in the magnetic gap. The iron-graphite mixture polishes but does not wear clutch parts.

In the unload status, both brake clutches are energized and are controlled by a reel release switch located below and to the left of the file reel (Figure 16). When this switch is depressed, power is removed from both brake clutches to permit them to be turned manually.

Visual Inspection and Operational Check

Check for worn or cracked brushes, loose Jones plugs, and frayed or broken wires. Check all clutches for powder leaks; powder leaks show up as a fine black powder on the covers and surrounding area. (Do not mistake black rubber deposits from drive belts as powder leaks.)

Clutches: Check that clearance between brush holder and slip ring is 0.040 to 0.068 inch.

Reel Drive Hubs: Inspect the rubber reel latch ring for uneven wear, breaks, cracks, dirt, and loss of elasticity.

Reel Drive Shafts: Check the reel drive shafts for lost motion, due to loose or worn taper pins used to connect the reel drive hub to the reel drive shaft.

Reel Drive and Brake Clutch Assemblies: Check the reel drive clutch bearings for binding and excessive wear. Rotary motion should be smooth and free, with no lateral end play. Check the clutch commutator rings for carbon deposits and excessive pitting.

The 729 magnetic clutch and brake response can be tested under worst-case conditions by programming the tape unit to perform a continuous write-backspace-read operation using long length records (1,000 to 20,000 characters). In most cases a 4,000 to 8,000 character record causes tape spill and pull out failures.

To test all six magnetic clutches thoroughly, the test must be run with a full reel on the left hub and again with a full reel on the right hub. The greater weight and larger diameter of a full reel subjects the clutches to greater stress. This test shows intermittent magnetic clutch failures which are not evident during continuous forward or backward tape motion. Items to consider in analyzing magnetic clutch failures are:

1. Magnetic clutch brushes and contact rings.
2. Vacuum column switches and associated circuitry.
3. Reel drive motor V-belt tension and wear.
4. Clutch and brake powder leakage and bearing contamination.

Cleaning

Reel Drive Hubs: Clean the rubber surface with a clean, lint-free cloth and approved cleaning fluid.

Reel Drive and Brake Clutches: Burnish the clutch commutator-rings with a fine crocus cloth, as required, to provide good electrical contact and to prevent arcing.

Belts: Belt tension should be ½-inch deflection with a ½-pound force applied in the center of the V-belt.

Lubrication

Reel Drive Hubs: If necessary, apply small amount of talcum powder on the rubber ring surface to prevent the tape reel from sticking.

Reel Drive and Brake Clutch Assemblies: Do not lubricate any portion of the clutch drive assembly; this may cause permanent damage to the clutches.

Stop Clutch Worm Gear: Apply IBM 24 grease as required.

Figure 52 shows the tape unit drive mechanisms.

Mechanical Adjustment

Belt Alignment and Tensions: Position the drive motors in their slotted holes for 0.5-inch belt deflection in the center. Deflection may be accurately checked by using a 0.5-inch spring scale.

Clutch and Brake Shaft Assembly End Play: End play on these shafts can be reduced by adjusting the nut on the rear of the shaft.

CAUTION

Do not make this adjustment too tight, as this will cause burned bearings and excessive drive motor load.

Electrical Adjustment

Brush-to-Clutch Commutator Ring Contact Resistance: With the tape unit power cut off, connect an ohmmeter to the brush and commutator ring of each clutch. This resistance should not exceed 25 ohms.

Brush-to-Commutator Ring Adjustment: To prevent arcing (which is a source of noise), make sure that there is 0.040 to 0.068 inch clearance between the brush block and the commutator ring.

Reel Drive Clutch Energizing Voltage: A tachometer generator is needed to make the necessary magnetic clutch current adjustments. Figure 54 shows the tachometer assembly, which is the one used on the IBM 1403 Printer (IBM P/N 461117).

Replace the reel knob with the tachometer assembly and connect it to an oscilloscope with a direct probe. Ground one terminal of the tachometer. Scope setting: 1 volt/cm and 50 ms/cm sweep. Trigger externally from the current jacks on the clutch adjustment panel (Figure 56). Adjust each clutch response with its respective potentiometer to obtain curves shown in Figure 55.

Use a full reel of tape when measuring and adjusting response. Loop a piece of magnetic tape into the columns, securing the end to the outside of the vacuum columns. Disconnect the capstan motors and load drive. The loop of tape is then physically positioned about the proper port to check response of the full reel mounted on the hub.

If the clutch response cannot be brought to specifications with full adjustment of the potentiometer, check the current in the circuit. With the potentiometer in the extreme clockwise position, the current should be 420 to 450 ma. If the current value is correct and the clutch is still out of specification, the clutch must be rebuilt.

Clutch response specifications (Figure 55):

1. Up and down clutch must obtain two-thirds of maximum speed in 0.135 to 0.150 second, with a full reel of tape.
2. The stop clutch must stop a full reel of tape from full speed in 0.145 to 0.160 second.

When a new or rebuilt clutch is installed, clutch response should be rechecked and adjusted if necessary after one week of operation.

Removal, Up and Down Clutches

Up and down clutches at the rear of the tape unit are best removed individually without removing the complete assembly.

1. Remove both side covers and top cover (four bolts, two on each side). The top cover need not be removed on machines with a slotted brush block support bracket and hex-head screws holding the bracket to the frame.
2. Support both left and right clutch assemblies with cord or wire suspended over the cross members supporting the air filter assembly.

NOTE: Do not bend clutch shaft. Walk belts off sheaves on clutch.

3. Remove wires from brush assembly between stop and center clutch. It is not necessary to remove wires on rear clutch brush assembly.
4. Loosen setscrew in high-speed rewind motor coupling.
5. Remove two dowel pins from rear support casting.
6. Remove four Allen head bolts securing rear support casting to main clutch support.
7. Remove head drive belt.
8. Remove rear support casting, including high-speed rewind motor, and lay across AC raceway and drive motors.
9. Remove adjusting nut, retainer, and bearing from rear of shaft.
10. Remove rear clutch from the shaft. Shims may be fitted here.

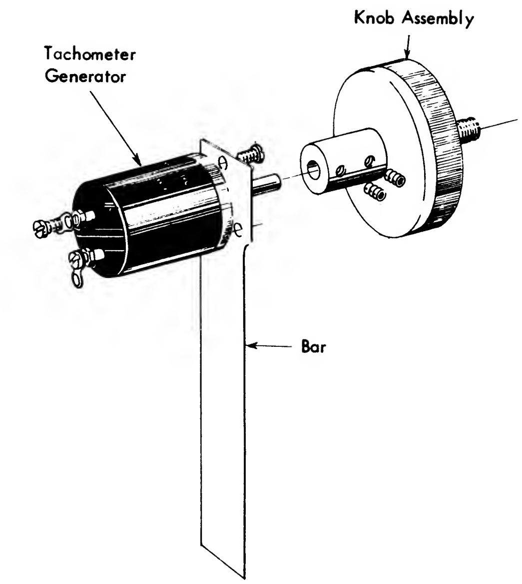


Figure 54. Tachometer Assembly

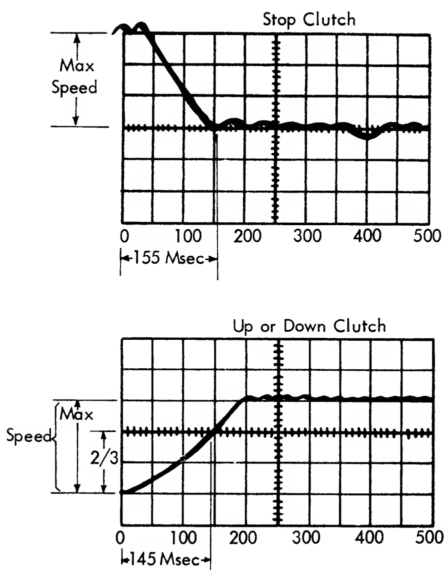


Figure 55. Typical Clutch Response Curves

CAUTION

Be sure front sliding glass is down. The shaft can slide forward and break the glass.

11. If center clutch is to be reworked, remove Woodruff key for rear clutch.

12. Slide center clutch to the rear as much as possible by hand.

13. Remove two screws holding brush block support bracket. The top one is best removed with a long screwdriver from the top; this is the only reason for removing the top cover. After removing the bracket, slot the top hole so that future removals will require only that the top screw be loosened.

14. Remove the two halves of the split spacer between the middle clutch and the stop clutch.

15. Slide the middle clutch to the front of the machine and remove its Woodruff key.

16. Slide middle clutch off the back of the shaft.

Removal, Stop Clutch

1. Remove both side and top cover.
2. In most cases it is not necessary to remove the long vertical side covers to drive the pin from the hub housing. Adequate swing on the hammer can be obtained by driving the pin upward. If the pin is extremely tight, however, it may be necessary to remove these interior covers (either side of front door).
3. Support shaft with V-block and drive pin from clutch hub.
4. Do steps 2 through 7 and 12 in removal procedure for up and down clutches.
5. Remove clutch assembly from the rear of the machine.
6. To remove stop clutch from shaft, remove the two halves of the split spacer after separating the stop and center clutches as much as possible by hand.
7. Slide the stop clutch to the rear of the shaft and remove its Woodruff key.
8. Slide clutch off front of shaft.

Reassemble in reverse order. Be sure to replace all shims in their original locations. When replacing nut on back of shaft, adjust for 0.005-inch end play and lock with retainer.

Clutch Brush Replacement

1. Completely disassemble brush block assembly.
2. For block assemblies that do not have soldered pigtails: Locate 0.250 inch from unbent end in center of strap. Punch and drill 0.052-inch hole (No. 55 drill). Countersink 82° × 0.093 inch diameter both sides (No. 42 drill). Hole should be centered over brush.
3. On block assemblies with soldered pigtails, unsolder the pigtail, keeping the hole clear of solder.
4. Insert new brush into block so that it seats properly on its shoulder.
5. Insert new spring over pigtail and allow to sit on brush.
6. Locate brass strap in position, allowing the pigtail to extend up through the drilled hole. Do not tin more than 1/16 inch of pigtail.
7. Solder pigtail to brass strap. File solder flush to within 1/32 inch.

CAUTION

Care should be used when soldering. Solder should completely fill the hole in the brass strap, but not

be allowed to flow down the pigtail. Apply solder sparingly; soldering will stiffen the pigtail, and in some cases of continued flexing, the pigtail will break. The pigtail should have enough slack to allow twisting of the brush. If the pigtail is not slack, the twisting action will pull the brush away from the slip rings.

8. Check brush for free action and full return to normal position.

9. Check resistance from brush to strap for a good soldered joint.

10. Clean slip rings with fine crocus cloth or polishing stick, P/N 450503. *Do not use tape cleaning fluid or lubricants of any kind.*

Clutch Recharging

1. Remove four screws and cover plate.
2. Remove outer (white) felt washer and inner (black) felt washer and discard.
3. Check bearing (P/N 535626) for binds. Replace if necessary.
4. Install new inner felt washer, P/N 333208, and rotating disk.
5. Fill chamber with powdered iron, P/N 332770. The vial contains a pre-measured amount (22 grams) of powder. Fill chamber from outer periphery, tapping and rotating chamber and disk. Use entire contents of vial.
6. Thoroughly clean shoulder where cover contacts the clutch housing.
7. Install new outer cover and washer assembly, P/N 554173, and secure with four screws.

NOTE: When rebuilding stop clutches, install takeup clutch rotor, P/N 332785. Using this rotor reduces incidence of binding clutches caused by breaking down of the powdered iron mixture. Old stop clutch rotor, P/N 332802, is obsolete.

Degauss the clutch parts, powder, and assembly tools to make cleaning and assembly easier.

Tape Reel Latch, EC 253041 (Figure 57)

A quick release tape reel latch, EC 253041, permits quick, positive mounting of magnetic tape reels. A handle, mounted on a pivot shaft, manually flips out 60° to permit mounting or removing a reel of tape. With the reel positioned, pressing in on the handle exerts a camming action against the thrust washers and belleville washers. Pressure exerted against the cover expands the wide split ring, holding the reel firmly on the hub.

A nylon pellet in the threaded portion of the pivot shaft keeps the handle from accidentally unscrewing, and a solid retainer ring fitted into a groove in the split ring prevents the split ring from flying off the hub if a

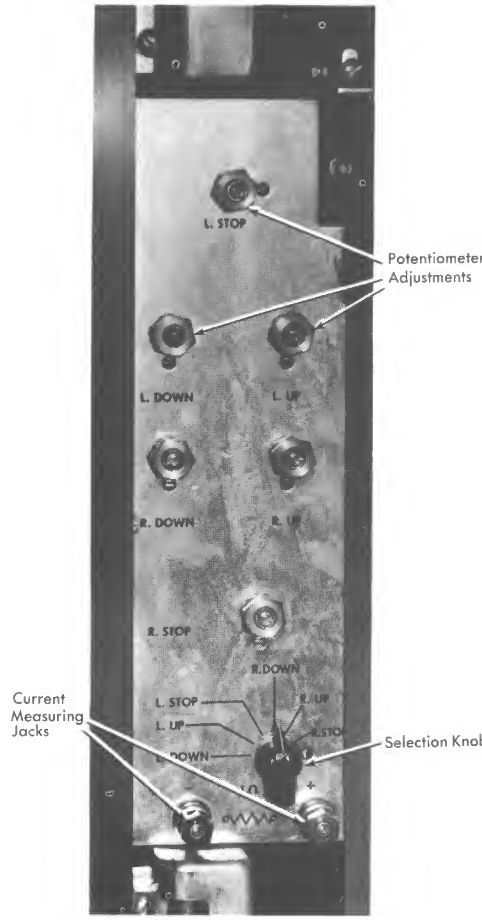


Figure 56. Clutch Adjustment Panel

high-speed rewind is executed with no tape reel mounted. Shims are added or removed between the pivot shaft and the reel drive shaft during assembly to adjust the camming action.

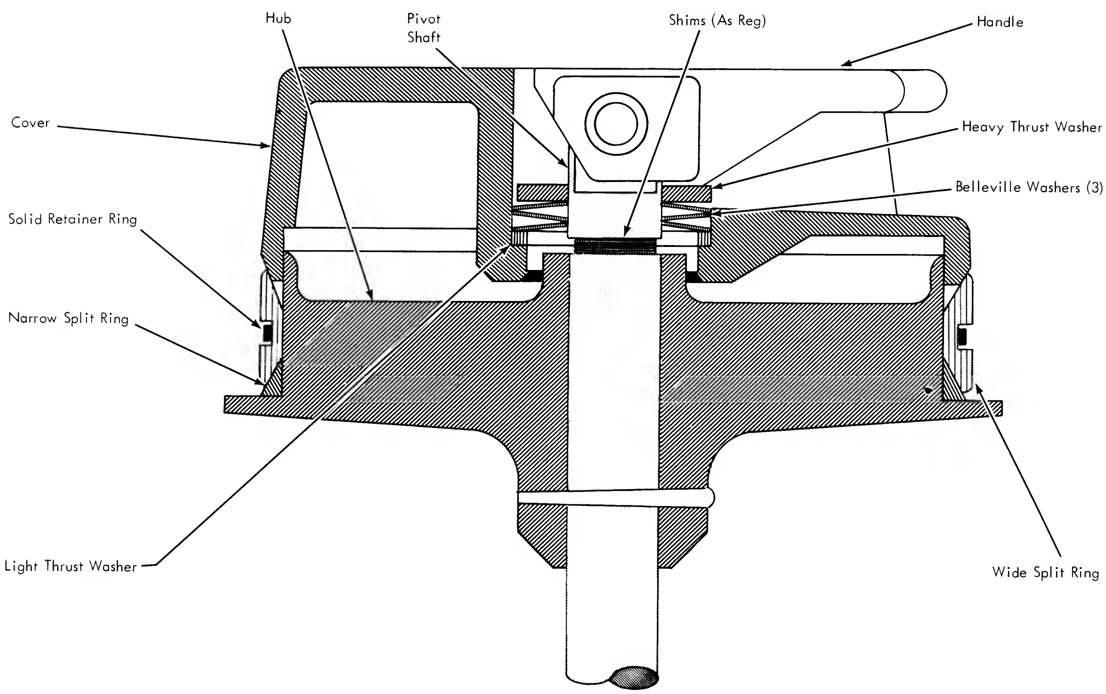
Cleaning

Magnetic tapes that have been used on units which employ rubber expansion rings may have rubber particles embedded in or adhering to the plastic reels. These particles transfer to the split rings or reel hubs when the tape is mounted on a unit with an installed tape reel latch.

Periodically inspect tape reel latches for rubber particles; remove particles with a typewriter brush or soft cloth to keep them from causing trouble in other areas of the tape unit.

Lubrication

Apply IBM 17 lubricant sparingly to the handle pivot pin and pivot shaft and to the side of the heavy thrust washer facing the handle cam, if the latch is removed from the tape unit for any reason. Do not lubricate any other part of the latch.



• Figure 57. Tape Reel Latch

Visual Inspection and Adjustments

Make sure that the inside diameter of the split ring rests on the outside diameter of the reel hub when the handle is in the open position, and that the cover has no axial play. If axial play is present, unscrew the handle and pivot shaft from the reel drive shaft and remove one shim. If the split ring does not rest on the outside diameter of the reel hub, unscrew the handle and pivot shaft and add one shim. After these conditions have been met, place a new nylon pellet, IBM P/N 5344963, in the pivot shaft thread cavity, and reassemble as described under "Removal and Replacement."

Removal and Replacement

To remove the tape reel latch, hold the reel hub with one hand. With the other hand, open the handle, and turn handle counterclockwise until the pivot shaft is completely unscrewed. Be careful not to lose any of the shims from the pivot shaft when removing the handle and shaft from the machine. The split rings may now be removed from the reel hub if desired.

Reassemble the tape reel latch to the hub in the following order:

1. Place the narrow split ring on the reel hub with the tapered side facing away from the flange. Push the ring snug against the flange.
2. Place the wide split ring and retainer assembly on the reel hub, and snug the tapers of both rings.
3. Position handle at right angle to the pivot shaft, and place heavy thrust washer on shaft.
4. Place three belleville washers on shaft: inside diameter of the first against heavy thrust washer, outside diameter of the second against the outside diameter of the first, and inside diameter of the third against the inside diameter of the second.
5. Visually center light thrust washer on outside diameter of the third belleville washer. Replace the shims on threaded portion of shaft.
6. Assemble cover to handle, carefully guiding the light thrust washer into the cover counterbore.
7. Hold both handle and cover assembly, and engage pivot shaft threads in the tapped hole in the reel drive shaft. Turn tape reel hub counterclockwise until cover approaches the split ring.
8. Open the handle and continue turning hub counterclockwise until pivot shaft bottoms against the shims.
9. Check that the adjustments are correct as described under "Visual Inspection and Adjustments." Add or remove shims if they are not.
10. When adjustments are correct, unscrew the handle from the reel hub, place a new nylon pellet, IBM P/N 5344963, in the pivot shaft cavity, and repeat steps 7 and 8 of the reassembly procedure.

Static Reducers

Tape motion, especially high-speed rewind, causes static electrical charges to build up on the tape reels (Figure 16). These charges are sufficient to cause load-

unload failures under certain conditions. Printed-circuit type static reducers, mounted at either side of the finger guard, limit this static buildup.

Adjustment

Mount empty tape reels, with file protect rings installed, on both reel hubs. Adjust static reducers for reel clearance by loosening the two screws that secure the printed board to the metal bracket and sliding the board in or out as required. The printed boards must clear all projections on the rear of the reel (minimum clearance). The end of the board should extend to within 1/16 inch of the position occupied by the innermost loop of tape on the tape reel.

Tape Take-Up Mechanism

The tape take-up mechanism consists of a three-phase motor mounted above and between the two reel clutch shafts (Figure 52) and is geared to each brake clutch housing so that when the left stop clutch housing is rotated counterclockwise by the motor, the right stop clutch housing rotates clockwise. With the brake clutches energized, the tape reels rotate so that tape is removed from the columns. When the tape take-up motor is reversed and the brake clutches are energized, the tape reels rotate so that tape is dropped into the vacuum columns. When the tape take-up motor is not operating, the brake clutch housings are held stationary by the worm drive mechanism.

High-Speed Rewind

To provide fast reel motion during high-speed rewind, an additional motor (1/12 HP, three-phase, 208 volts, AC, 3450 RPM) is direct coupled to the file reel shaft. During normal tape motion, the rotor is turned with the file reel shaft. When the tape unit goes into a high-speed rewind operation, the magnetic clutches are de-

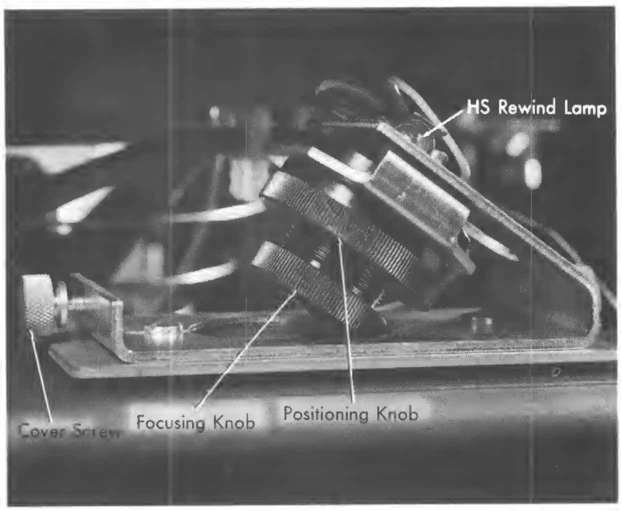


Figure 58. High-Speed Rewind Lamp Assembly

energized and the high-speed rewind motor drives the file reel shaft. Tape is pulled directly from the machine reel. The location of the high-speed rewind motor is shown in Figure 52.

Mounted to the rear of the takeup reel shaft is an eddy current sensing device (Figure 59). Its purpose is to sense when the reels have coasted to a stop so that tape can immediately begin loading into the columns.

Operational Check

Run the tape unit through the high-speed rewind cycle and compare the performance against the following requirements:

1. With just over ½ inch depth of tape on the machine reel, the tape unit should begin a high-speed rewind operation when the LOAD REWIND is depressed.
2. When the depth of tape on the machine reel is reduced to ½ inch, the tape unit should kick out of the high-speed rewind and begin braking the machine reel.
3. When rewinding a full reel, the tape unit should brake smoothly to a stop, so that there is 1/16 inch of tape on the machine reel before loading tape.
4. The tape unit should take between 40 to 70 seconds to rewind a full reel. Approximately two-thirds of this time should be in high speed and one-third in low speed.

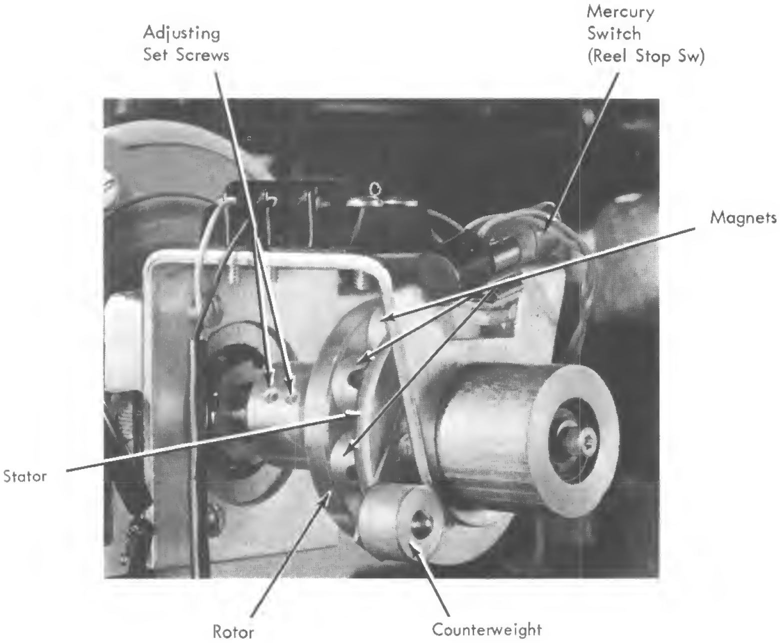
If the operation does not meet the requirements, adjust as necessary.

Adjustment

1. Check for 0.0 ± 0.2 volt at A3D10D (TU.09.30.1). Adjust with the sliding tap on resistor R19 located in the motor control box (Figure 31).
2. Focus and position the high-speed rewind light (Figure 58) so that the vertical slot of light is centered on the photocell in the finger guard between the reels.

The light and focusing mechanisms are located behind the operator's panel, on the right side. To adjust, open the panel and remove the light cover. The large knurled ring is used for positioning and the small ring for focusing.

3. Run ½ inch of tape onto the machine reel, and unload the tape unit.
4. Pull the finger guard cover forward and turn clockwise for unobstructed view of photocell hole.
5. Using the large positioning ring, move the light beam so that the shadow of tape on the machine reel just cuts across the top edge of the photocell hole.
6. Set the machine reel brake adjusting potentiometer at mid-position. This is R10, mounted on the hinged cover of the motor control box.
7. Hand wind approximately 25 more turns of tape onto the machine reel.
8. Press the load rewind key. If the adjustments to this point are correct, the unit should go into high-



• Figure 59. Eddy Current Sensing Device

speed rewind. If it does, go on to the next step; if not, recheck the shadow on the photocell (steps 3, 4, and 5) and repeat steps 7 and 8.

9. Run a full reel of tape onto the machine reel.

10. Rewind the full reel and check the results against the requirements listed in "Operational Check." To meet these requirements, it is necessary to adjust the eddy current sensing device and brake potentiometer for 1/16 inch of tape before loading. Check by using a full reel of tape.

Eddy Current Sensing Device (Figure 59)

This device is mounted on the rear portion of the machine take-up reel shaft and consists of two main sections.

A 2-inch circular plate (rotor) with eight permanent magnets secured to it is fastened to the reel shaft and is free to rotate with it. A second plate (the stator) is mounted on a fixed bracket and is free to turn within limits. This plate is placed close to and parallel with the eight magnets. On this second plate is a mercury switch and a counterbalance. The switch is the reels stopped switch, SW36, normally closed*. During a high-speed rewind, the force of the magnets tends to overcome the counterweight, move the assembly clockwise (from the rear of the machine), and open* the contacts. The switch will remain in this position until the reel coasts to a near stop; the counterbalance will then rotate the assembly counterclockwise again. This will close* the switch and signal the circuitry that the high-speed rewind portion of the cycle has ended.

Visual Inspection and Operational Check

To check for the proper sequence of operation, the following procedure should be followed:

1. Place a full reel of tape on the right reel (machine reel).
2. Disconnect the tape take-up motor.
3. Press the load-rewind key.
4. After the tape drive has picked up speed in a high-speed rewind, press the reset key.
5. Observe that when the eddy current switch transfers and picks relay 6, the reels have just come to a stop. It is not necessary to look at R6; it will make an audible click. Increase the gap between the rotor and stator for less time delay and decrease the gap for more delay.

Adjustment

Adjust the gap between the rotor and the stator to approx. 0.006 inch. (Use one IBM card to make this adjustment.)

The internal contact prongs of the mercury switch must be on a horizontal plane.

Form the arm holding the mercury capsule so that the switch just makes with the capsule at rest. Check for consistent operation by moving the device back and forth several times.

*For units that have had EC 252528 installed (CEM 93).

NOTE: If the switch is adjusted so that it rocks back and forth during low-speed operation, the mercury can cause switch breakage and improper operation. Exercise care in this area.

Base

Front Door Assembly

The sliding glass spring drum assembly controls the sliding glass panel of the front door (Figure 60). A spring drum assembly is located on each side of the inside of the door (Figure 61).

Lubrication

The following lubrication should be performed every four to six months, or more frequently depending on usage.

1. Lubricate the springs and spools with IBM 6.
2. Use grease stick, P/N 461077, on the door check latch cam face, and the surfaces of the nylon tube seals that guide the sliding window.
3. Apply IBM 17 sparingly to the door latch.

Guide Adjustment

The front door sliding glass is tapered so that it is narrower at the top than at the bottom. With the window closed, there normally is a minimum of play sideways (about 1/16 inch maximum). With the window open there will be a maximum of 5/16 inch. Because of this, any adjustment to the glass should be done with the window closed.

In and out movement is to be held to a maximum of 1/32 inch.

Magnet Assembly Adjustment

1. With the outer cover in place, and the sliding window raised, loosen the two magnet holding screws (C, Figure 62).
2. Position the magnet assembly against the top of the outer cover and tighten the two magnet holding screws. The sliding window should now be held shut by magnetic attraction.

Removal and Replacement, Drum Spring Assembly

1. Raise the sliding window.
2. Remove outer cover.
3. Remove three screws (A, Figure 62) which secure holding arm to sliding window.
4. Remove securing nut B, and lift spring from stud D (Figure 62).
5. Remove pivot pin and clip (E, Figure 62), and remove spool. Note that spool is split to facilitate spring removal.
6. Assemble in reverse order. No adjustment is required.

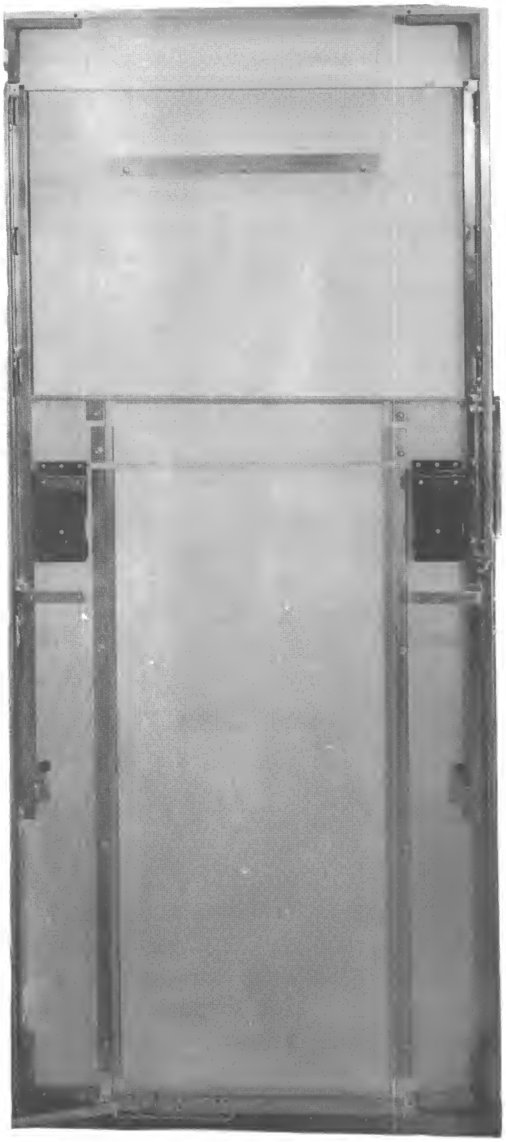


Figure 60. Sliding Glass Assembly

Reel Door Interlock

An interlock switch in the upper left corner of the tape unit is closed when the tape unit door and its sliding plastic panel are closed. When the door interlock switch contacts are open, all operations are prevented except unload. The interlock switch may be disabled for service and test purposes by a sliding plunger in the switch assembly.

Check the door interlock switch contact resistance with an ohmmeter while vibrating and operating the switch. Replace any switch having contact resistance or a noisy "make." A door interlock switch that does not make good contact can introduce noise on the read or write buses.

Adjustment

The switch should transfer when the sliding glass is 1/16 to 5/32 inch short of seating in its closed position.

File Protection

The rear surface of each tape reel is relieved so that it accepts a plastic write-enable ring. Insert the ring to write on a tape. Remove the ring to protect information recorded on a file tape.

The file-protect circuit uses two relays, a file-protect plunger, and a file-protect indicator lamp. The file-protect plunger protrudes from the front of the tape unit above the file reel hub, and is mechanically coupled to the armature of a not-file-protect relay, NFP-1 (Figure 16). Mounting a tape reel that contains a write-enable ring depresses the plunger and mechanically transfers the contacts of NFP-1. When the reel has been loaded and rewound to load point, a second relay, NFP-2, picks. Then write and erase head circuits are conditioned to allow the computer to write on tape.

The file protect lamp lights when a tape is file-protected, and goes out when a tape is write-enabled (not file protected).

Visual Inspection and Operational Check

1. Manually operate the file-protect plunger, and check for binds and mechanical damage. Inspect for clearance between the plunger and the left stop clutch.
2. With tape unit unloaded, hold down the reel release key and push in the file protect plunger. The plunger should be held retracted through the transferred NFP-1 relay points to prevent scraping bits of plastic from the write-enable ring when tape is being threaded.
3. Release the reel-release key. The plunger should return to the extended position.
4. Mount and load a work tape that contains a plastic write-enable ring. The file protect lamp should remain ON during the load-rewind operation, and go OUT when tape reaches load point.

Cleaning

Clean the file-protect plunger and surrounding area with a clean, lint-free cloth and approved cleaning fluid.

Lubrication

Apply IBM 6 oil sparingly, as required.

Adjustment

Bend and form the file-protect relay strap for proper operation when the file-protect plunger is depressed and released. Loosen the relay mounting screws and position the strap in its elongated holes as required.

Removal and Replacement

To remove the file-protect relay, disconnect the file-protect relay wires and remove the mounting screws. To replace, reverse the above procedure.

Motors

Visual Inspection and Operational Check

Check all motors for binding shafts. On forward and reverse motors, remove drive belts and spin each motor shaft by hand. They should coast to a smooth stop. Bent shafts can also be detected by turning the shaft through 360° by hand and feeling for sticking or dragging.

Check all pulley and coupling setscrews and taper pins for tightness on the following: drive capstan motors, blower motors, forward and reverse pulleys, high-speed rewind coupling, and the two take-up motors.

All resilient motors have a bond wire across the rubber resilient mounting. The frames of all motors are grounded through a green wire to the machine frame. All motors have a Jones plug for quick disconnecting.

Check all motor plugs for loose connections (Figure 63). Inspect all drive belts for wear. The plug shell is completely insulated inside. All motor leads have a heavy PVC sleeve or tape which extends well down inside the shell and is securely held by the clamp. It is important to make sure that this sleeving is pushed well down inside and clamped after being removed.

Relays

Visual Inspection and Operational Check

Refer to Figure 31 for relay locations.

Duo Relays: Check for dirty points, sticky pivots, loose cores, loose contact points and contact piles, and for correct armature-core air gap.

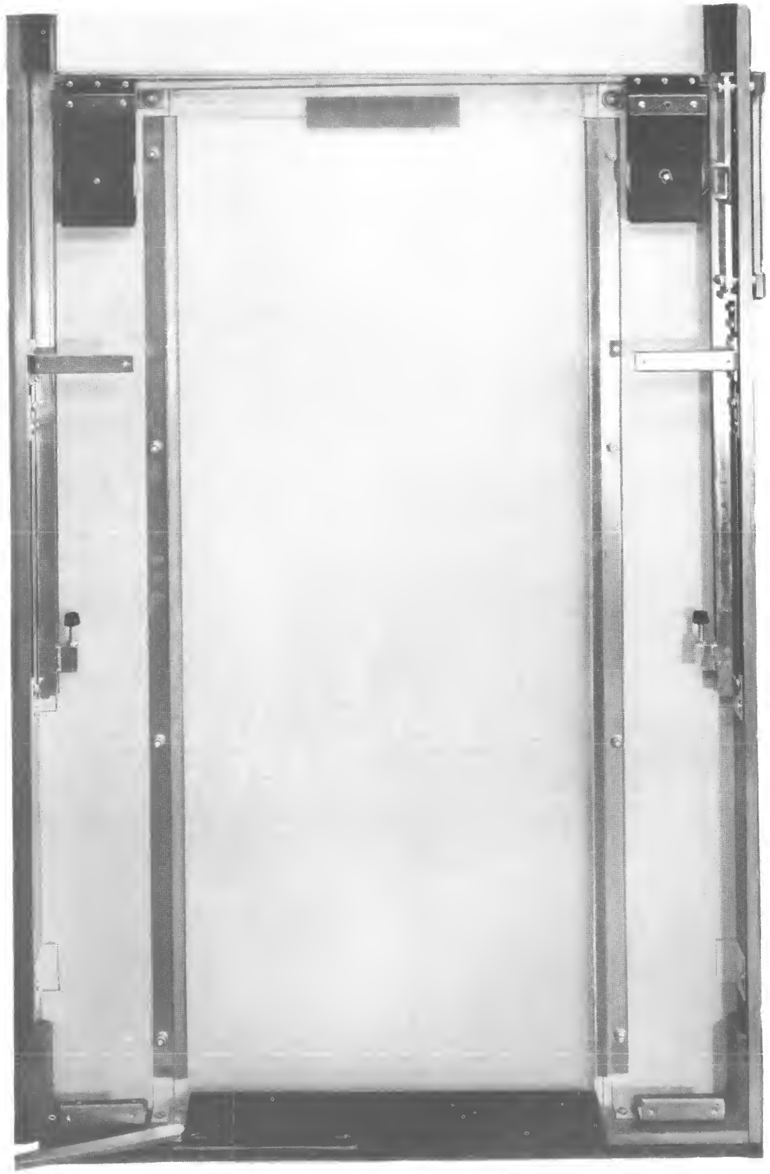
Heavy Duty Relays: Check for free armature movement, dirty contact points, and simultaneous make-break operation.

Cleaning

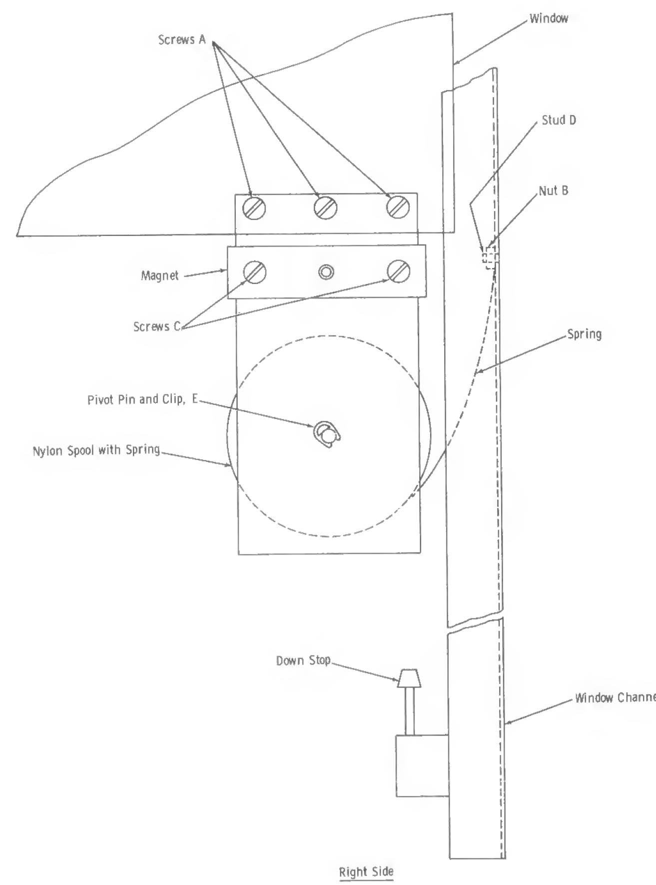
Recondition relays by following procedures outlined in the Customer Engineering Reference Manual, *Relays*, Form 225-5857.

Lubrication

Lubricate duo relay operating pads with IBM 17 and the pivots with IBM 6.



• Figure 61. Sliding Glass and Drum Spring Assembly



• Figure 62. Drum Spring Pulley Assembly

Adjustment

Duo Relays: Set the armature-to-core gap (when open) between 0.017 and 0.019 inch. Set the air gap for all contact points between 0.001 and 0.006 inch when a 0.007 inch gage is inserted between the armature and the brass armature stop pin. See that the gage does not interfere with the rivets holding the phenolic actuating pad to the armature. Use the same gage for making all adjustments.

Other Relays: Follow the adjustment procedure outlined in the Customer Engineering Reference Manual, *Relays,* Form 225-5857.

Filters

Visual Inspection and Operational Check

Inspect three filters for dirt. One filter is directly above the high-speed rewind motor and the other two are at the bottom of the transistor panel gate. Replace filters when they are dirty.

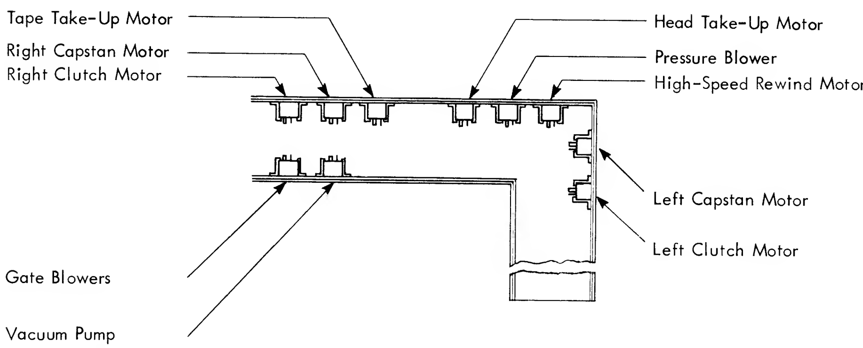


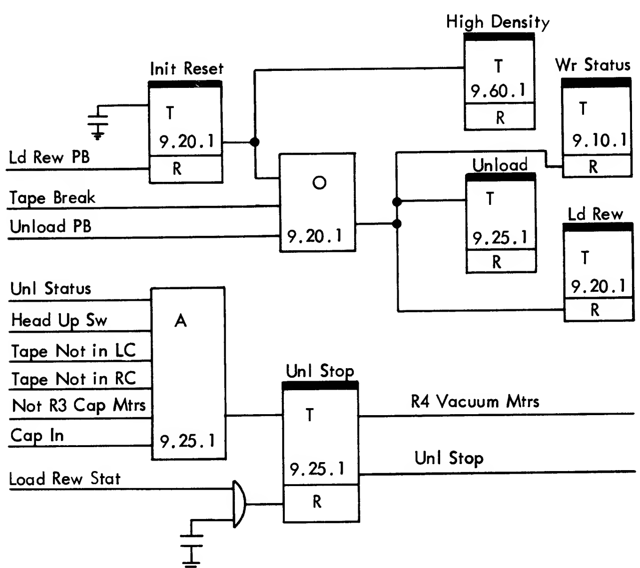
Figure 63. AC Raceway Plug Locations

Initial Reset

When power is first brought up on a tape unit, the following sequence of events takes place, insuring that the tape unit is fully unloaded and ready to receive the customer's reel of tape:

1. Turning on power sets the initial-reset trigger and resets the unload-stop trigger in the tape unit.
2. High density is set, according to machine specifications.
3. The write status trigger is reset to inhibit tape unit write and erase circuits; thus no valuable information will be destroyed.
4. The load-rewind trigger is reset and the unload trigger is set.
5. If the tape unit was not unloaded before dropping power, resetting the unload-stop trigger allows the vacuum motor to run until an unload operation is completed: head up, tape out of both columns, and capstans retracted.
6. The tape unit is now ready to receive a reel of tape.
7. The first depression of the load-rewind key resets the initial-reset trigger, and that trigger remains reset as long as power is applied.

Figure 64 shows that either a tape break condition occurring during a high-speed-rewind operation, or an impulse from the unload key, causes all of the same reset functions except the change of density status.



• Figure 64. Initial Reset Logic

Prolay Operation

Tape motion is controlled by two prolays which operate the prolay idlers. Each prolay has three operating positions: stop, go, and neutral. The status of a prolay is determined by energization of one of its three sets of magnet coils. Status of the prolays for various tape unit operating conditions is:

TAPE UNIT STATUS	PROLAY STATUS LEFT	PROLAY STATUS RIGHT
Fwd Stop	Stop	Neutral
Fwd Go	Neutral	Go
Bkwd Stop	Neutral	Stop
Bkwd Go	Go	Neutral

Visualizing the mechanical operation will undoubtedly be more helpful than memorizing a fixed set of conditions. When moving tape forward, the right prolay idler presses tape against the spinning right drive capstan, pulling tape across the read-write head. When moving tape backward, the left prolay idler and drive capstan are used. In each case, the opposing prolay is in neutral status, and has no effect on the tape. To stop tape forward motion, drive current is applied to the left prolay stop coil, causing the left prolay idler to press tape against the left stop capstan. The right prolay is switched to neutral status; tape does not contact either the right stop or drive capstan when the tape unit is in forward stop status.

Circuit Description

A logic diagram of the control circuitry is shown in Figure 65. Although the actual circuitry used in the machine is different, the figure should prove helpful for understanding the operation.

Whenever the tape unit is not in use, it automatically assumes a forward stop status. From the preceding table we note that this prolay status is left-stop and right-neutral. Tracing the forward and stop lines in Figure 65, A_1 and A_3 become active, satisfying our prolay requirements.

When a command is given to move tape forward, the right capstan is energized to pull the tape, while the left capstan is put in the neutral position. Tracing the circuit, A_2 and A_8 become active, again satisfying the prolay requirements. By tracing the backward-go and backward-stop conditions, the rest of the circuitry can be resolved.

The logical circuit of Figure 65 bears little resemblance to the prolay circuitry shown with its associated

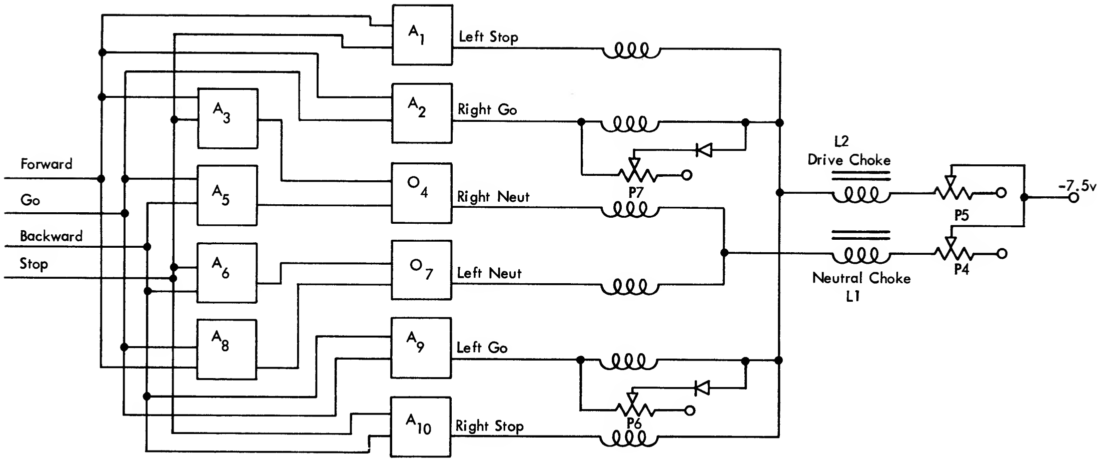
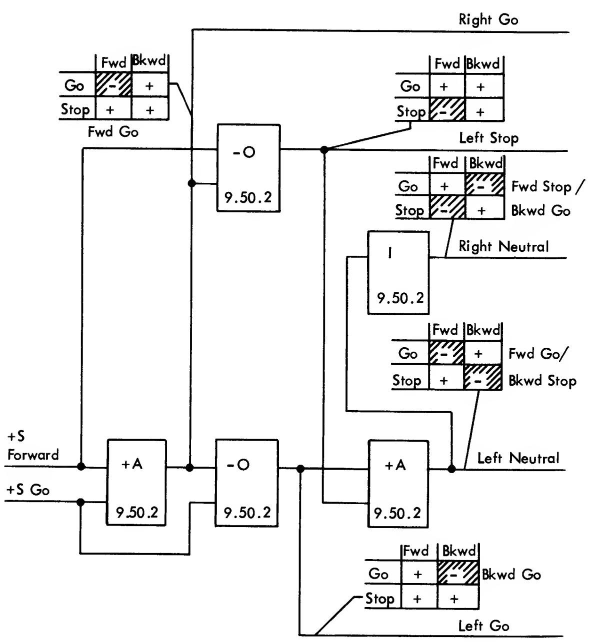
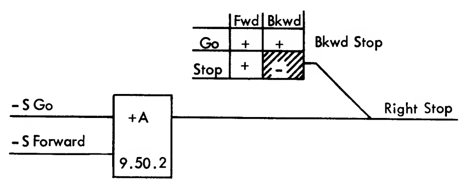


Figure 65. Prolay Control Logic





Condition	Prolays Used
Forward Go	Right Go and Left Neutral
Forward Stop	Left Stop and Right Neutral
Backward Go	Left Go and Right Neutral
Backward Stop	Right Stop and Left Neutral

• Figure 66. Prolay Control Circuit

NOR blocks in Figure 66. Negative outputs are required to activate the prolay drivers. To help in determining the outputs, a matrix of forward-backward and go-stop conditions is shown for each output line. The negative are the active conditions, and are shaded.

Magnetic Clutch Control

The magnetic clutches must produce an organized movement of magnetic tape for the operation being performed. Six clutches are provided for this purpose: an up, a down, and a stop clutch for both right and left tape reels (Figure 67).

Two sets of circuits determine the movement of the clutches. One set is controlled by the circuit logic and functions when the tape is either unloaded, or being loaded into or unloaded from the vacuum columns. The other set is under control of the vacuum column switches.

Circuit Description (NOR Logic Control)

Until tape is loaded into the columns, relay nine (clutch control) is not energized. The normally open points (Figure 67) deactivate the +140-volt circuit of the vacuum column switch and transfer control to the full- and half-brake NOR circuitry.

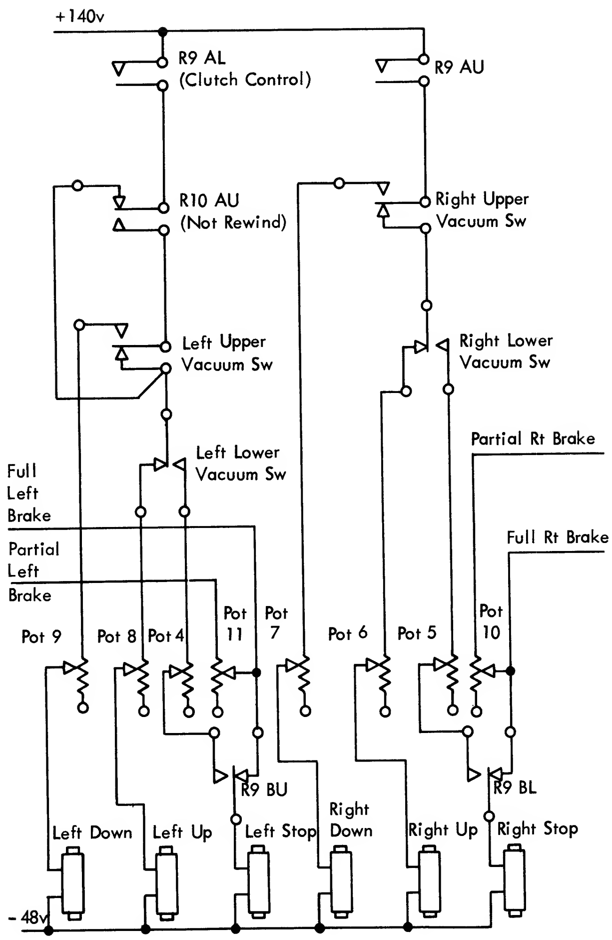


Figure 67. Clutch and Vacuum Control Circuitry

Unload Status

With the tape unit unloaded, A_1 (Figure 68) combines not reel release PB and unload brake condition to apply full brake to both reels. (Unload brake condition is essentially the output of the unload stop trigger on Systems 9.25.1.) The outputs of O_6 and O_7 are at +W level, completing the −48-volt circuit to activate the left and right stop clutches through R9 contacts.

The reel release key mounted on the front of the unit de-energizes the stop clutch circuit to allow mounting and threading of magnetic tape by the operator.

Load-Rewind (Low-Speed Area)

Pressing the load-rewind key sets load-rewind status (Systems 9.20.1). Load-rewind status resets the unload-stop trigger to pick R4 (Figure 64) and deconditions A_1 (Figure 68). When the vacuum bellows switch transfers, R1 and R2 (run) pick (Systems 9.20.1).

R1 and R2 run mix with tape not in left column and tape not in right column at A_5 and A_8 to produce partial brakes. Adjustment of potentiometers 10 and 11 limits partial brake current flowing through the stop clutches.

At this point, the up and down clutches play no part in loading tape. Both reels are turned by the tape take-up motor and its associated worm gears, which mesh with a fixed gear on the stop clutch (Figure 52).

Partial brake is switched to full brake as soon as tape enters the vacuum column. Tape in left column, tape in right column, and R1 and R2 run condition A_2 and A_3 to energize full left and right brakes. This circuit is effective until R3 (capstan motors) and R9 (clutch control) pick. At that time, control is fully transferred to vacuum switch circuitry.

Unload

Unload is the reverse of the load operation just described. A_2 and A_3 provide full left and right brake until tape leaves the columns, at which point A_5 and A_8 apply partial brake until the unload operation has been completed. Once the tape unit is fully unloaded, R1 and R2 (run) drop. The unload-stop trigger is set, causing unload stop and not reel release PB to condition A_1. Full current is applied to the left and right stop clutches via A_1, O_7, and O_8, respectively.

High-Speed Rewind

The high-speed interlock trigger is turned on at the start of a high-speed rewind and remains on until the tape take-up motor begins lowering tape into the columns.

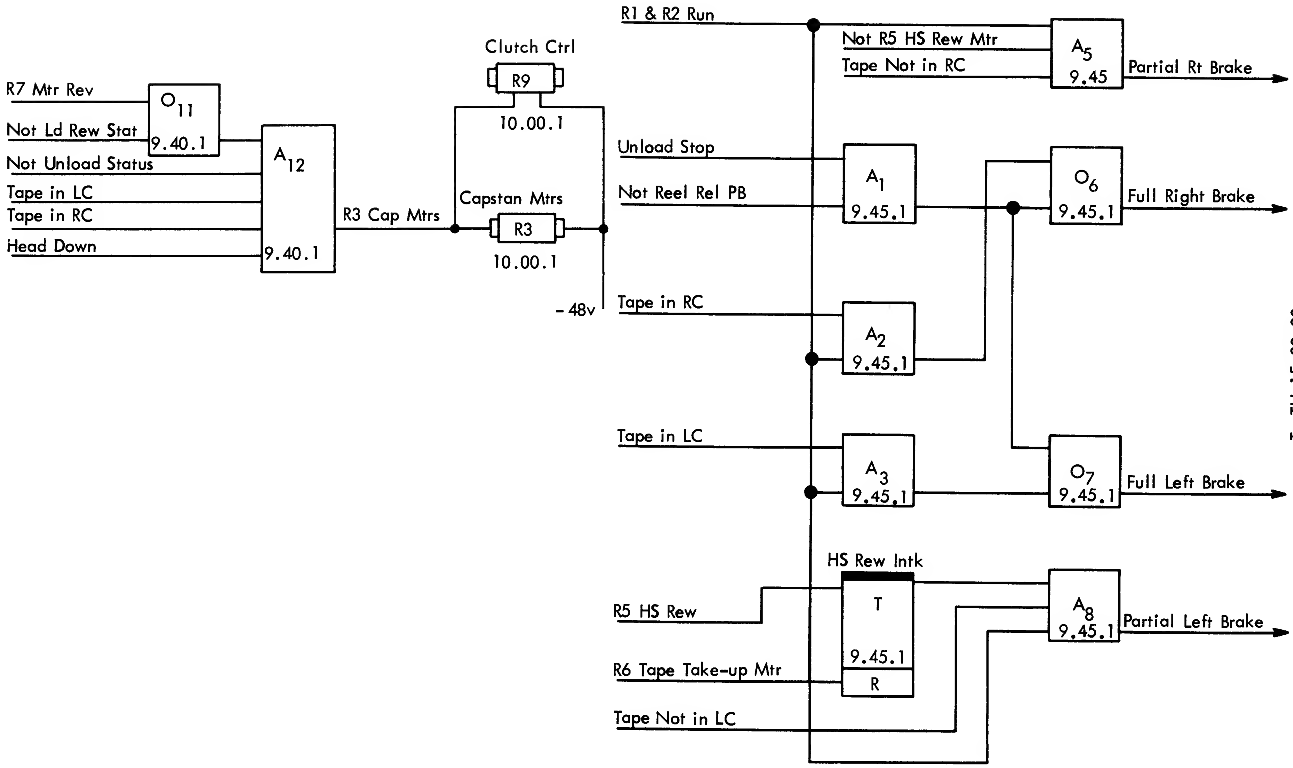
During the high-speed portion of the operation, no electrical brake is applied to either reel. As soon as the photocell recognizes that the machine reel radius has been reduced to ½ inch of tape, the high-speed rewind status trigger (Systems 9.30.1) is reset. This, in turn, drops relay five and opens the high-speed rewind motor circuit. At this point, A_5 applies partial brake to the right reel. The drag produced by the right brake causes both reels to come to a smooth halt.

Circuit Description (Vacuum Switch Control)

With the head down and tape in both columns, A_{12} is conditioned, and R3 (capstan motors) and R9 (clutch control) are picked. Picking R3 energizes the capstan motors, while picking R9 transfers control of the magnetic clutches from NOR logic to +140-volt vacuum switch circuitry (Figure 67). Note that there is now a total of 188 volts across the clutches, compared to the 48 volts discussed previously.

Forward Motion

In a forward direction, tape maintains itself about the upper left and lower right column vacuum switches. The left loop rises until the upper vacuum hole in its column is passed. Vacuum then causes the upper switch to transfer, logically energizing the left down



• Figure 68. Brake Control Logic

clutch to feed more tape from the file reel. The circuit consists of +140 volts, relay 9 AL N/O, relay 10 AU N/O, left upper vacuum switch N/O, potentiometer nine, left down clutch, and −48 volts.

As tape is lowered in the column, the upper vacuum hole is passed, and atmospheric pressure is returned to the upper switch. At this time the points return to their normal position, transferring control to the left stop clutch as follows: +140 volts, relay 10 AU N/O, left upper vacuum switch N/C, left lower vacuum switch N/O, potentiometer four, relay nine BU N/O, left stop clutch, and −48 volts.

With the tape maintained in position about the upper vacuum hole, the lower vacuum switch has vacuum and therefore is in the transferred condition. The switch in this position completely eliminates the left upper clutch, because tape should be fed only into the left column and not out of it.

On the right side, tape maintains itself about the lower vacuum column hole. The loop of tape is lowered into the column as tape is fed across the read-write head by the capstans. In order to remove the tape from the column and wind it on the machine reel, the right up and stop clutches are used. Because the right upper vacuum switch remains in a normal condition, its N/O points completely eliminate the right down circuit (Figure 67).

Backward Motion

When tape is driven backward by the capstans, the loop tends to rise in the right column and lower in the left. Logically, then, the right down clutch must feed tape from the machine reel while the left up clutch winds the tape on the file reel. The stabilizing points will now be at the right upper and left lower vacuum column holes. With this information it should be simple enough to trace the appropriate circuit paths on Figure 67.

Load Rewind

A load rewind operation first lowers tape into the columns by means of the tape take-up motor in reverse, and then conditions the prolays for backward go. Backward movement, as has been explained, causes tape to position itself at the lower left vacuum hole.

During the loading part of the operation, both relay three (capstan motors) and relay nine (clutch control) pick as soon as tape enters the tops of the columns and produces vacuum. At this time, the left upper vacuum switch transfers and attempts to energize the left down clutch. At the same time, both capstans are feeding tape into the left column. Tape coming in from both directions could very easily result in a loop that would extend too far below the lower hole and into the manifold screening. If this happened, one of the tape-in-

column switches would transfer and drop ready status on the unit.

To prevent this condition, a rewind operation opens the circuit to the left down clutch as tape is entering the columns. In Figure 67 note that the relay ten AU N/C points bypass the left upper vacuum switch. If the head down first change (EC 252528B) has been installed on the tape unit, the possibility of tape dumping into the columns is further minimized, since tape is not fed into the columns until the head has started down.

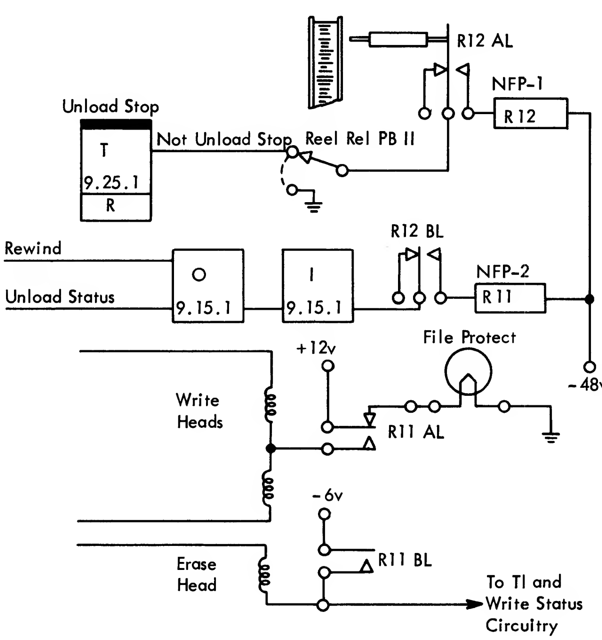
File Protection

Customers' program and data tapes are valuable property. They contain information that may be difficult or impossible to recreate. It is essential to take every possible precaution to protect this information.

The file-protect circuit is designed to prevent writing on tape. An operator can disable tape unit write and erase circuits by removing a plastic ring that fits a groove in the rear of the tape reel. Absence of this ring puts the tape unit in file-protect status and is fail-safe: if the ring falls out, the file is automatically protected. Placing the ring in the reel allows writing. Reading can take place whether the ring is present or not.

Circuit Description

R12 (NFP-1) and R11 (NFP-2) are used in the file protect circuit. Both relays must be picked to write on tape (Figure 69). The circuit operates as follows (note that positive relay logic is used to protect recorded information in case of any circuit failure:



• Figure 69. File Protection Logic

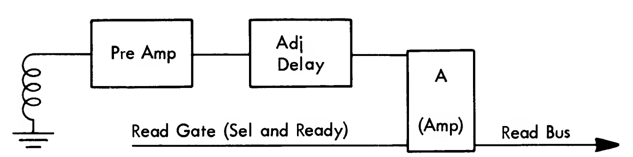
1. When the tape unit is unloaded, R12 and R11 are dropped, and the file protect light is energized through R11 AL n/c. R12 is not picked because the unload stop trigger is on.
2. Mounting a tape reel that contains a plastic write-enable ring depresses a plunger to mechanically transfer the R12AL (NFP-1) points.
3. Pressing the reel-release key picks R12 through the R12AL points. The plunger is retracted, keeping it from scraping bits of plastic into the transport while tape is being threaded. R11 cannot pick because the tape unit is in unload status. R12 drops as soon as the reel release key is released.
4. Pressing LOAD-REWIND resets the unload-stop trigger to pick R12 a second time; the plunger again retracts.
5. Rewind status (9.15.1) blocks R11 from picking at this time to prevent accidentally erasing tape during a rewind operation.
6. When tape reaches load point, rewind drops and R11 picks, turning off the file protect light and conditioning the write head and erase head through n/o points of R11AL and R11BL.
7. Write head and erase head circuits are now under control of the write status trigger (9.10.1).

Read Circuits

The read circuits recognize a flux change on tape by a small voltage induced in the winding of the read head, amplify it to a usable level, and make it available to the controlling unit.

Circuit Description

Changes in flux (bits) induce signals of approximately 14-35 mv as tape passes over the read head (Figure 70). These signals, amplified approximately 500 times, feed an adjustable delay line. The delay line compensates for read skew, so that pulses from all tracks will be available simultaneously; its output feeds the pre-amplifier output stage. Since the output stage is conditioned by read gate, signals are placed on the read bus only when the tape unit is in selected and ready status.



• Figure 70. Read Circuit Logic

Write Circuits

The write circuits feed current to the appropriate write heads to produce recognizable flux patterns on tape. Writing is controlled by an external unit which determines the track or tracks to be used, as well as the bit density. Echo pulses, generated by the writing circuit, are fed back for use by the external device. A file is protected by deconditioning the write circuits whenever a file reel does not have a plastic ring inserted.

Circuit Description

Externally generated signals, such as write pulses, write buses, and write check character, are available to all connected tape units. Select and ready (Figure 71) conditions A_1 and A_2, isolating a write operation to the particular tape unit addressed.

If a write bus line is conditioned, the output of A_3 complements the write trigger; that is, if the trigger was set, it is reset, and vice versa. Complementing the trigger causes the driver to reverse current flow through the write head winding to write a bit on tape. In addition, the driver generates a write echo pulse which is sent to the controlling unit. Adjustable delays are set to compensate for the various causes of write skew, so that all bits of each character are written across the tape in a straight line.

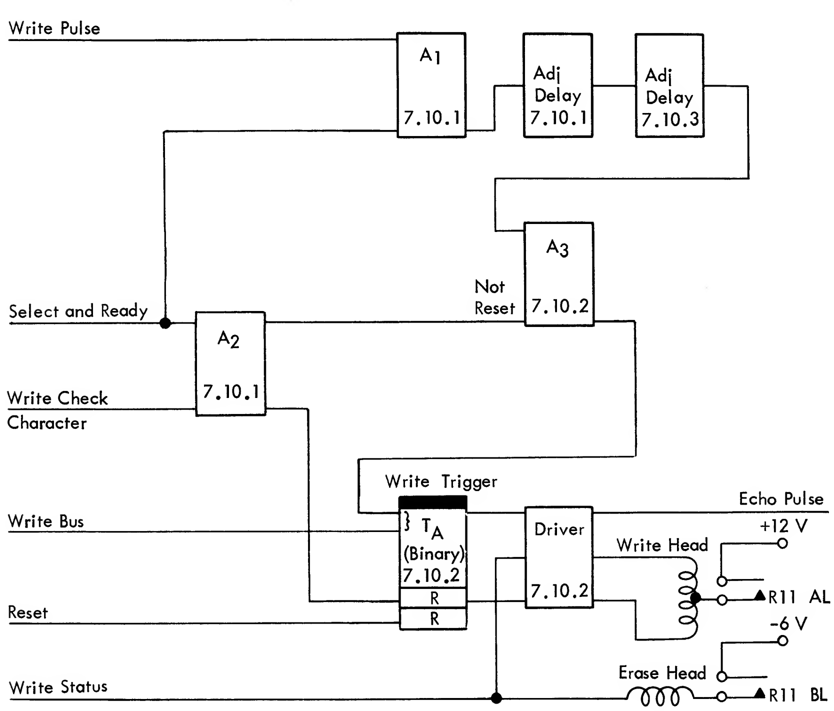
To write a check character, A_2 is conditioned, generating a pulse to reset the write trigger, if it is on. Dropping the select and ready line deconditions A_1 and A_2, to prevent noise from affecting the write trigger while the write head is positioned in the interrecord gap.

File protection safeguards the circuits not only by the R11 AL points, but also in the write status line and its generation shown on Systems 9.10.1. For a more detailed explanation of the write circuit see the section on special component circuits.

High-Low Density

In a tape unit that moves tape past the read-write head at a fixed rate of speed, tape density (number of characters written per longitudinal inch of tape) is a function of external control unit timings. The high and low density circuitry which is built into 729 Tape Units permits setting each unit to either high or low density status, and allows the drives attached to a system to be operated at different, mixed densities. Density control circuits built into the 729 are strictly a remembering device, and have no effect on the operating characteristics of the tape unit.

The NOR density circuitry is essentially a DC binary trigger (Figure 72). In addition to alternating density status with each depression of a key, it must also set specific conditions under initial reset or program control. Some of the circuitry functions only during specific operations. Figure 73 shows only the circuitry



• Figure 71. Write Circuit Logic

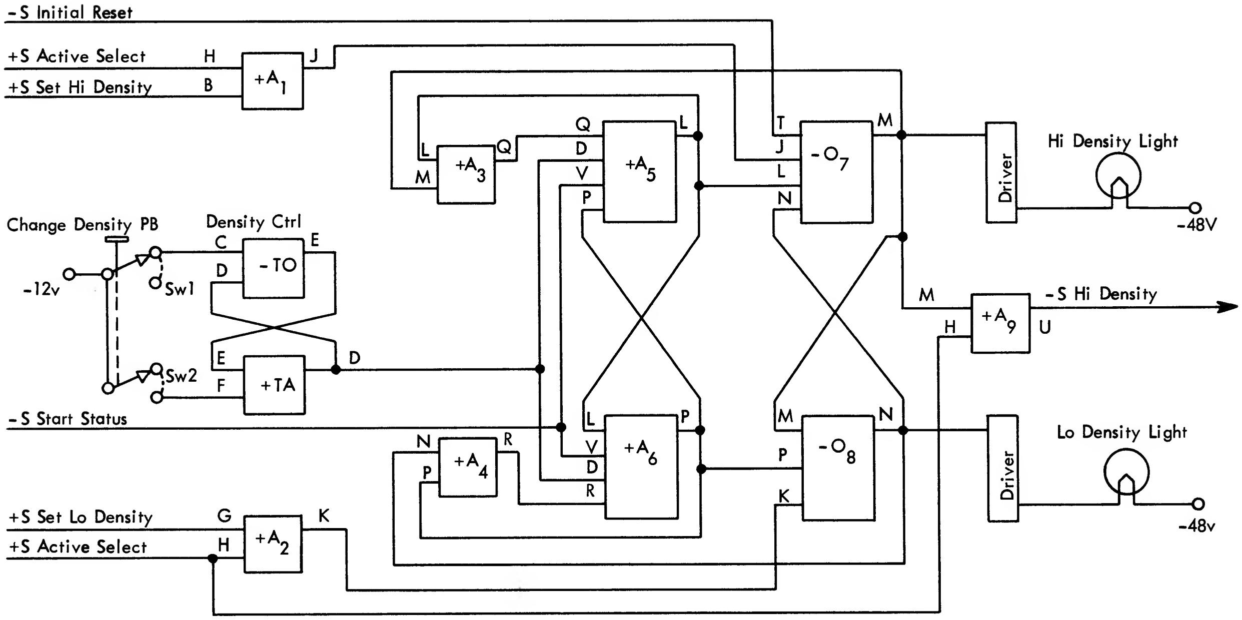


Figure 72. High-Low Density (Logic)

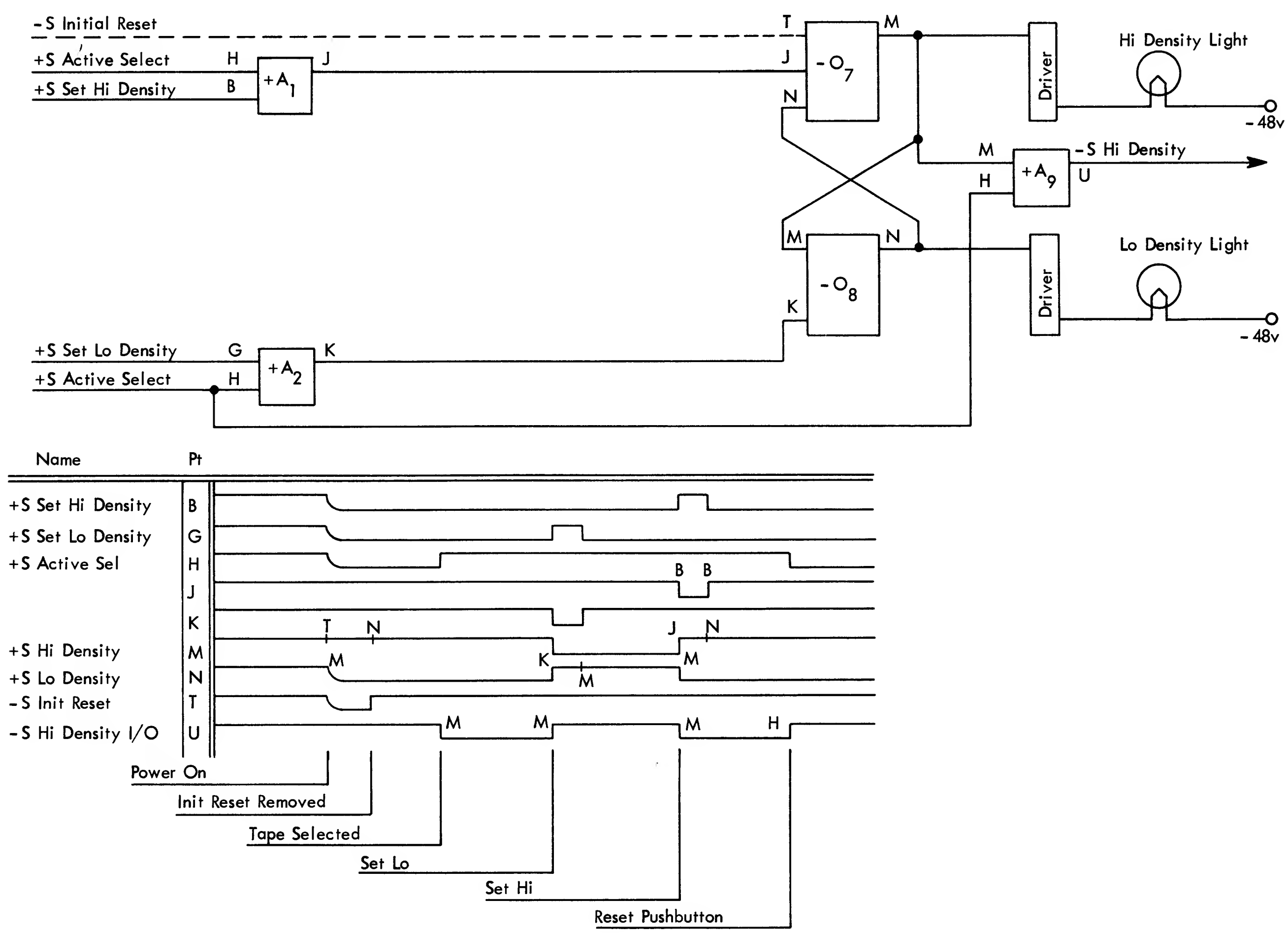


Figure 73. High-Low Density (Reset and External Control)

which is active under reset and external control; Figure 74 shows only the active circuitry for manual key operation. Figure 72 shows both; note that active portions, during their operation, do not affect the non-active portions.

Circuit Description

Density Control Trigger

The density control trigger functions to eliminate electrical noise due to contact bounce, thus helping stabilize the circuit transition from one density to another. The normal position of the change density key applies −12 volts at point C of the −TO Block. This raises the output E; with point F floating, the output of the trigger at point D will be at a −S level.

When switch 1 opens, point C floats. Electrical noise will have disappeared from C before point F is lowered to −12 volts. When switch 2 closes, point D will go to +S. This immediately lowers point E, and latches the trigger. Any electrical noise remaining at point F will have no further effect, since E is now holding the circuit.

In summary, the static output of the density control trigger (point D) is −S. Depressing the change density key changes this output, maintaining it at +S until the key is released.

Initial Reset

Initial (power-on) reset unconditionally sets the tape unit to high density. During this operation, both J and K (Figure 73) remain at a +S level. Initial reset drops to a −S level, which in turn brings the output M of O_7 to +S. M now feeding back to O_8 causes output N to drop to a −S level. This, then, maintains the established condition on O_7 and also extinguishes the low density light. Point N holds the tape unit in high density even though the initial reset condition may be removed at a later time.

High-Low Program Control

Figure 73 shows the essential circuits for program control of density. Assume high density status. A change to low density will result from a signal received from the controlling device. Before this can become effective, however, the tape unit must be selected. Selection conditions A_1 and A_2 so that the set low density line at G causes K to fall to a −S level. This is fed into O_8, causing N to rise and lighting the low-density light. N, at the same time, feeds into O_7, causing M to drop to a −S level. M at O_8 now hold low density, even after the initial pulse at K has disappeared.

By following the same logic at A_1 for set high density, it is seen that low density can be reset and replaced by a high density status.

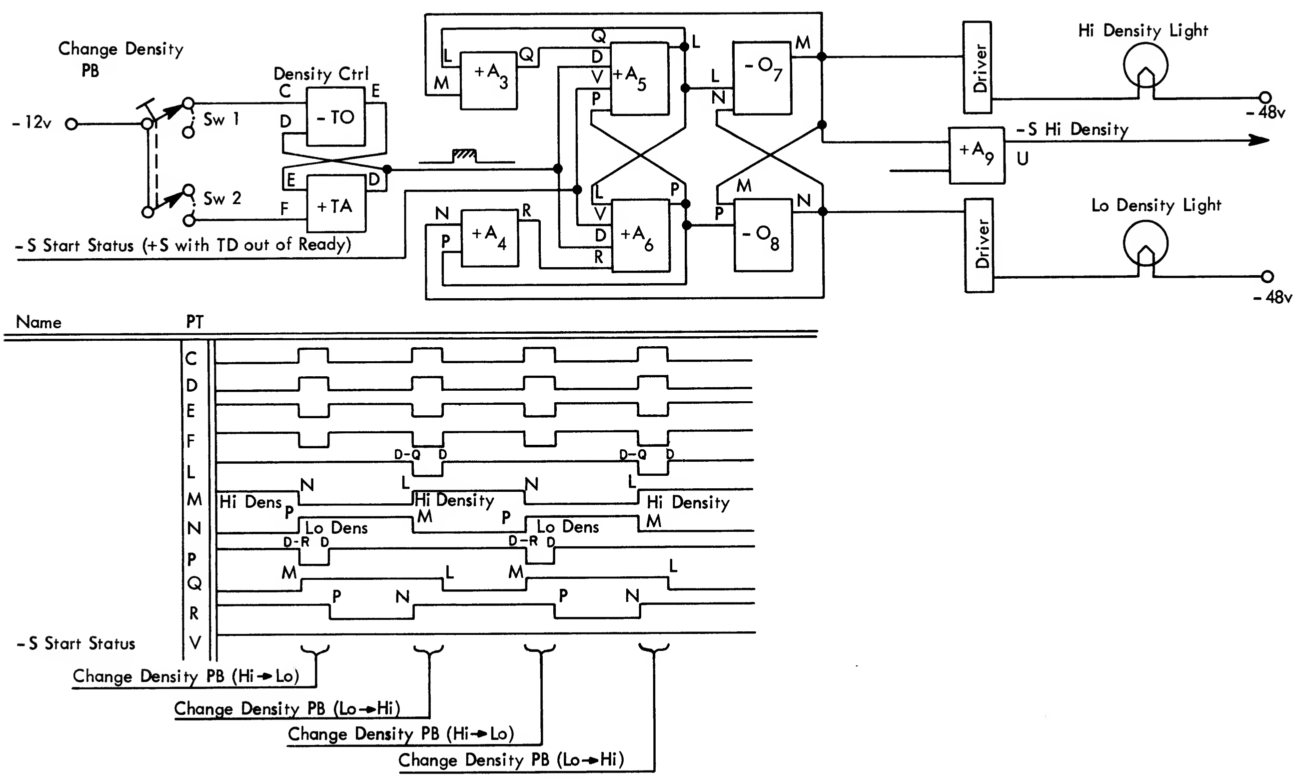


Figure 74. High-Low Density (Key Control)

High-Low Key Control

The density circuit for key operation (Figure 74) is essentially a DC binary trigger. Its status will be changed with each depression of the change-density key. One major controlling line is start status. The machine must be out of ready (start) status for the key to be operative. With this in mind, note that point V will be at +S level throughout the entire operation, and can be eliminated from the discussion.

There is a certain symmetry of the circuit which might be: O_7 and O_8 determine the final status by bringing either point M or point N to a +S level. Two controlling blocks, A_5 and A_6, effect a change in the status of O_7 and O_8 under control of line D from the density control trigger and its associated key. A_3 and A_4 are essentially gate switching devices, letting line D alternately affect A_5 and A_6.

Assuming that high density is set, M is at +S while N is at −S. Line D (normally −S), feeding into A_5 and A_6, causes both points L and P to be at +S. These four lines feeding into A_3 and A_4 produce a −S level at Q and a +S level at R. A_3 deconditions A_5 for the next depression of the key. The +S level of R gates the next key pulse into A_6 (all four inputs +S), dropping point P to −S at O_8 and causing the trigger to flip from high density status and latch into low.

Low density status drops R and raises Q, so that A_5 is now gated and A_6 deconditioned. The following plus pulse on line D activates A_5, drops L to −S, raising point M, producing high density. M, of course, drops N through O_8 and extinguishes the low density light.

Load Point

The system circuits as well as the programmer need to know when the file reel is at the beginning of tape (load point). A trigger in the tape unit remembers and indicates this fact when tested by subsequent operations. A photocell and lamp combination is used in conjunction with a load point reflective spot to detect the desired condition.

The reflective spot is placed on the glossy side of the tape, about 10 feet from the physical beginning and 1/32 inch from the front edge as viewed looking at a reel mounted in the machine. The lamp and photocell are mounted close to the read-write head (Figure 75). When the strip passes across the head, light from the lamp is reflected into the cell. The load-point trigger is then set until the tape is removed from its load point position.

Circuit Description

When tape enters either column, transfer of the corresponding tape-in-column switch activates the driver circuit to turn on the load-point lamp. R20, a 150-ohm variable resistor mounted in the motor control box, allows adjustment of light intensity (Figure 75).

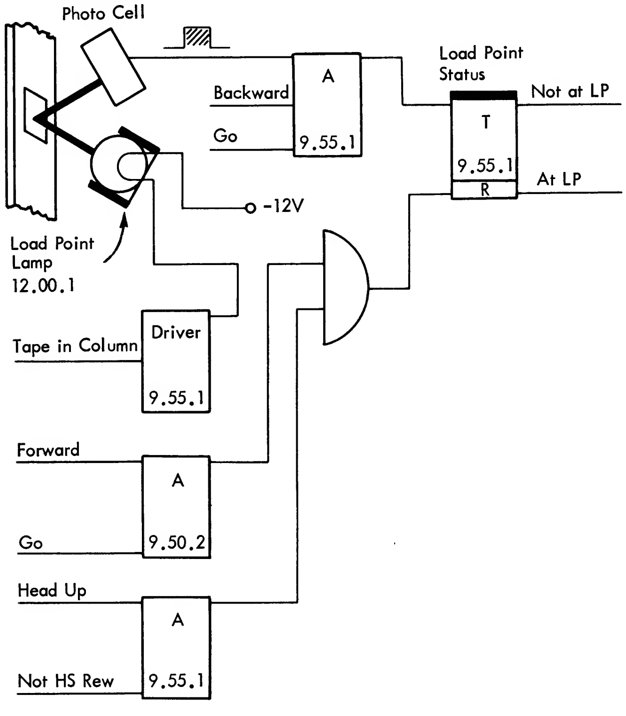
As tape moves backward during a backspace, rewind, or load rewind operation, light from the load-point lamp is reflected by the aluminum strip into the load-point photocell. As a result a ten μs pulse is generated and combined with backward and go (A_1), turning on the LP trigger. The output of this trigger is then sampled to determine the physical position of tape on the machine. The trigger remains on until tape is moved forward from load point as determined by a forward-go condition in A_2. Unloading the tape unit also turns off the trigger and holds it reset until another load-rewind operation is initiated.

Tape Indicate

The tape-indicate trigger is available to the attached system for interrogation, and may be used to indicate a physical condition within the tape unit itself, or for other purposes connected with the customer's program.

Circuit Description

The tape-indicate trigger is turned on during a write operation as soon as the end-of-tape reflective spot passes under the tape-indicate lamp and photocell. A_1 turns it on when the 10 μs pulse is emitted by the photocell and its associated circuitry (Figure 76). In



• Figure 75. Load Point Logic

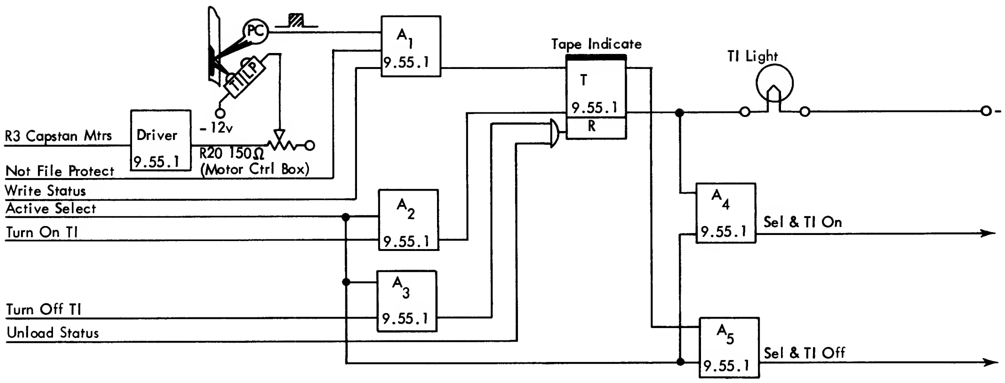
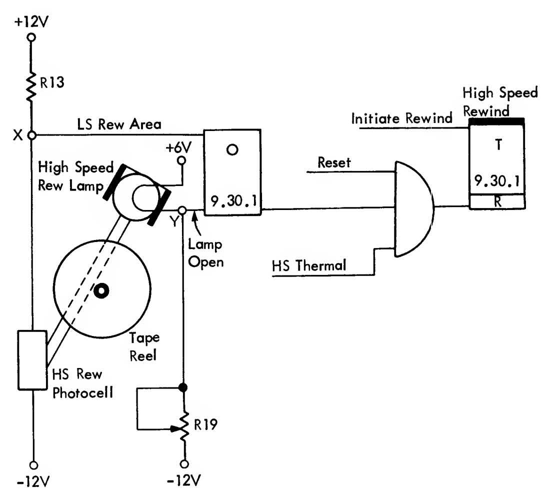


Figure 76. Tape Indicate Logic

this case, the turn-on of the trigger is a sign to the system that the end of tape is near; this does not hinder the writing operation. A program, ignoring this, would pull the tape off of the takeup reel as writing was continued. Therefore the program, recognizing EOT, will logically close the file, and turn off the indicator through A_3.

Sometimes it is convenient to pin-point a particular tape unit in programming. Note that A_2 can turn on the tape indicator upon an external signal which may originate in either external circuit conditions or program control.

Finally, the tape-indicate trigger is turned off as the result of an unloading operation.



• Figure 77. High-Speed Rewind Lamp

High-Speed Rewind Sensing

Tape will be removed from a high-speed rewind condition if any of four logical conditions exist:

1. There is less than ½ inch of tape on the machine reel. This condition is sensed by the photocell and lamp arrangement (Figure 77). The lamp, mounted in the upper right-hand corner of the tape unit, is beamed between the sides of the machine reel so that it strikes the photocell mounted in the finger guard. When the tape builds up on the machine reel, light beam to the cell is blocked.

2. The high-speed rewind lamp is burned out. This condition is continuously monitored by machine circuits as explained below.

3. Tape breaks during a high-speed rewind operation. Light from the tape break lamp is directed toward the load point photocell. If tape breaks, light strikes the cell and produces a machine reset. This in turn resets the high-speed rewind trigger. (See Tape Break Circuit Description.)

4. The high-speed rewind thermal switch has been tripped by a faulty or overheated motor. This switch is physically mounted within the casing of the motor.

The logic of these conditions is shown in Figure 78. The high-speed rewind trigger is set only at the beginning of the rewind operation (initiate rewind). If any one of the reset conditions is present at that time, the trigger cannot be turned on and a high-speed operation cannot take place.

If the trigger is turned on at the start of a rewind operation, it remains on until reset by one of the conditions. Normally this will occur when the photocell circuit senses ½ inch of tape.

Circuit Description

Activating initiate rewind always trys to turn on the high-speed rewind trigger (Figure 77). If successful, a high-speed rewind sequence can take place.

When there is less than ½ inch of tape on the machine reel, light reaching the photocell reduces its resistance, and it conducts heavily; the voltage at point X goes negative, resetting the trigger. The trigger is also reset if the high-speed rewind lamp burns out (point Y at −S level), or if the high-speed rewind motor overheats. With the high-speed rewind trigger reset, rewinding operations take place only at low speed.

Overall high-speed rewind logic is shown in Figure 78.

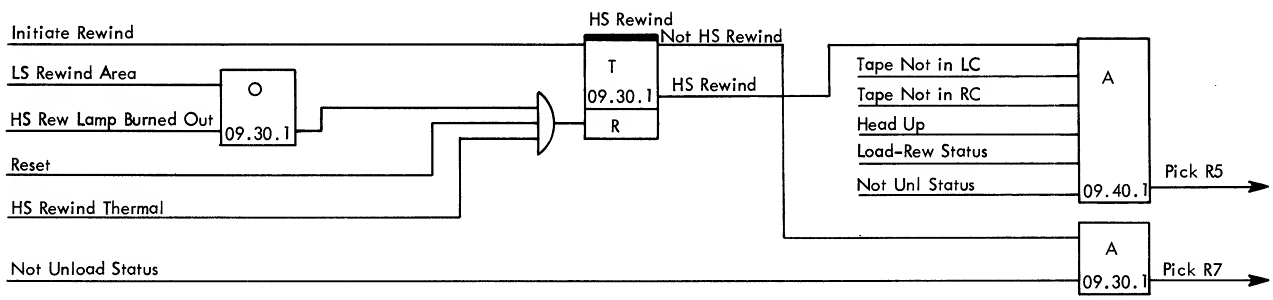
Tape Break

It is possible for tape to break during a high-speed rewind when the reels are spinning at a high velocity. A faulty drive, poor condition of the tape itself, or improper mounting by the operator could cause this. Throughout the high-speed period of the rewind there is no electrical brake applied to either of the machine reels. A break at this time could result in a great deal of additional damage to the tape itself if it were allowed to flap against the inside framework of the machine. To prevent this, a photocell and lamp combination will sense the break, whereupon full electrical brake is applied immediately to both reels. In addition, the machine is returned to a normal unloaded condition.

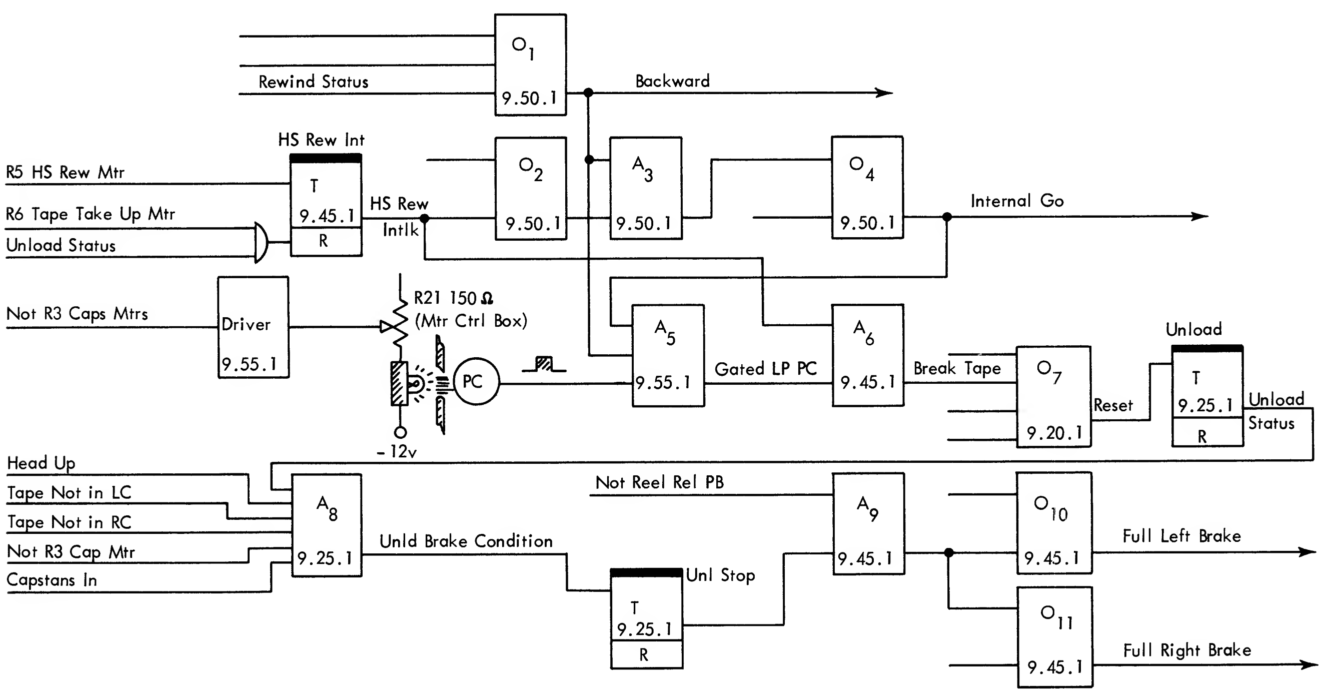
Circuit Description

The tape-break lamp is mounted in the tape cleaner assembly and directed at the load-point photocell. As can be seen in Figure 79, the lamp is lit only when the capstan motors are not energized, or when the tape unit is either unloaded or in process of a high-speed rewind.

When tape is passing between the lamp and photocell, no light reaches the cell to cause an output. If tape breaks, however, light strikes the cell, causing a 10-μs positive pulse output.



• Figure 78. High-Speed Rewind Logic



• Figure 79. Tape Break Logic

After tape has been raised out of the columns, R5 (high-speed rewind motor) is picked and the high-speed interlock trigger is turned on. The trigger is reset by R6 (tape take-up motor) when R6 is picked to start loading tape back into the columns again. Therefore, the trigger gates only the high-speed area of the operation. The trigger output brings up internal go by conditioning O_2, which, in turn, conditions A_3 mixed with backward.

The pulse from the photocell circuitry mixes with backward and GO in A_5 and produces gated LP PC. This mixes at A_6 with high-speed rewind interlock, and through O_7 turns on unload status. At this point, A_8 is conditioned and turns on the unload-stop trigger. The unload stop trigger being on conditions A_9, which immediately forces full left and right brakes via O_{10} and O_{11}.

At this point, the reels have come to a complete stop and the tape unit is restored to a normal unloaded status.

Load Rewind

As the name implies, the object of this operation is to load the tape properly from the file reel into the transport mechanism; and to rewind it to load point, ready for system operation.

Pressing the load-rewind key starts two distinct operations: (1) loading the tape into the vacuum columns and across the read-write head, and (2) rewinding the tape to load point. The rewinding operation is conditioned by pressing the key, but does not actually begin until the last sequence of the load operation is completed. Because the tape might be in a high-speed area, a test must first be made to determine the course of events at this point. Also, before any phase of the operation can begin, the machine must be placed in read status with all write and erase circuitry inhibited. If these precautions were not taken, valuable information might be destroyed.

Circuit Description—Low Speed—Tape Unit Initially Unloaded (Figures 80, 81, 82, 92)

Before the load-rewind key can affect the circuit, the machine must be out of start status, or an accidental load rewind could occur during computer operation. Gating for this condition, as well as the starting point of the operation, will be found on Systems 9.10.1 with gated ld rew PB. The immediate result of this pulse is to reset the write status trigger, if it is on, to assure removal of the write heads and erase head from the circuits. For an explanation of this and the picking of relays 11 and 12, see the section, "File Protection." Mixing the off condition of write status with the remainder of the key pulse produces initiate rew and allows the operation to proceed.

Initiate rew turns on the load-rewind trigger (Systems 9.20.1) if the capstans are not out, and R7 (motor reverse) is not conditioned. Load-rewind status turns off both the unload and unload stop triggers and picks R4 to start the vacuum motors. While manifold vacuum is building up several additional operations occur.

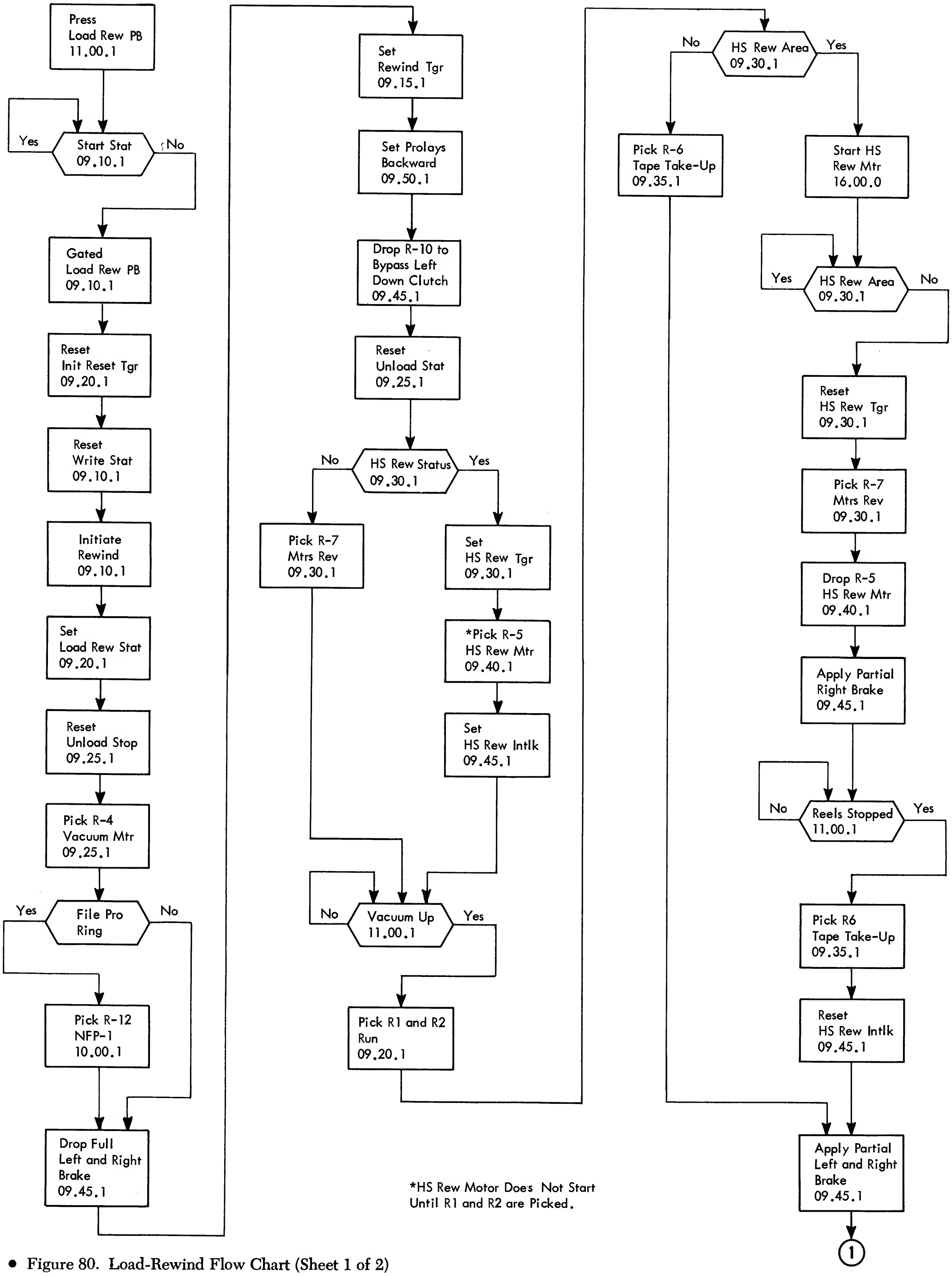
An attempt is made to turn on the high-speed rewind status trigger (Systems 9.30.1). Since less than ½ inch of tape is on the machine reel, the trigger is held reset and the initiate rewind pulse has no effect. (See the section, "High-Speed Rewind Sensing".) Because both the tape and head must be lowered during this operation, relay seven (motor reverse) is picked to reverse the phases and direction of the tape take-up and head-up motors. At this point, relay seven conditions only the three-phase input circuitry; the motors themselves are picked after other conditions have been met.

Initiate rewind or load-rewind status sets the rewind trigger (Systems 9.15.1) after the unload-stop trigger is reset. Rewind status feeds circuits shown on Systems 9.50.1, which immediately drop forward and condition the prolay circuits for backward movement. Final conditioning involves internal go, which is not available until tape is fully loaded and the capstans are extended and energized. Rewind status also drops relay ten (not rewind status), removing the left down clutch during the loading operation. (See the section, "Magnetic Clutch Control.")

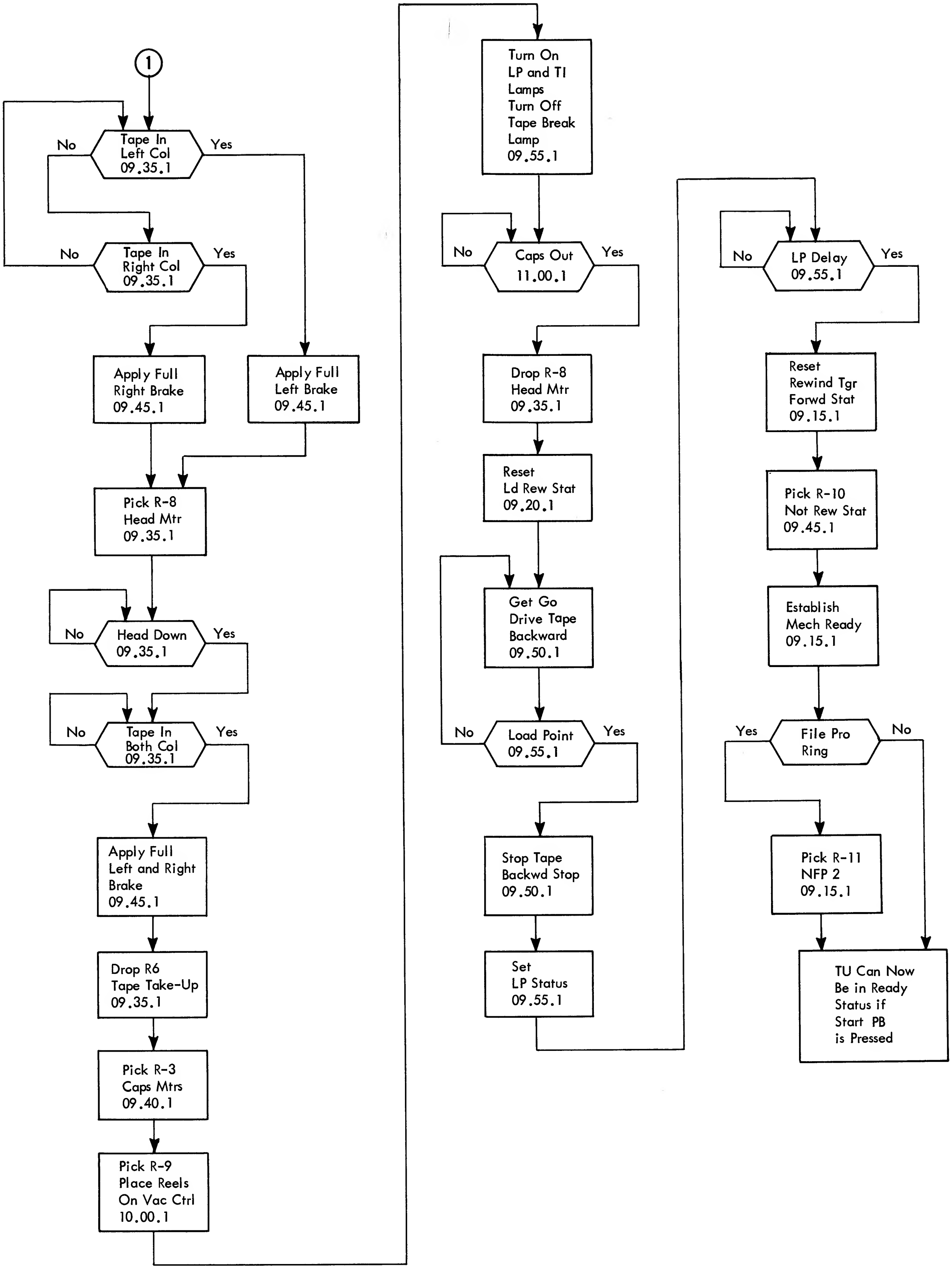
As soon as vacuum rises in the manifold, the bellows switch opens (Systems 11.00.1) and mixes with load-rewind status (Systems 9.20.1) to pick R1 and R2 (run) relays. These double pole relays complete circuits to the forward and reverse clutch drive motors to start them turning. Power is furnished also for the rewind, capstan, tape take-up, and head-up motors so that they can operate when their corresponding relays are energized.

The next operation loads tape into the columns. The tape take-up motor trigger (Systems 9.35.1) has one set line and several reset conditions. Reel stopped, which indicates that the machine is not in a high-speed rewind condition, continually tries to turn on the trigger. Here, vacuum is the controlling factor. The bellows switch, in transferring, removes the only active reset and allows relay six (tape take-up motor) to pick. The motor runs in reverse and, through worm gears on the stop clutches, drives both the file and machine reels, lowering tape into the columns. This operation continues until the trigger is again reset by load gate, conditioned by tape in both columns, and R7 motor reverse. The last condition essentially signifies a load operation.

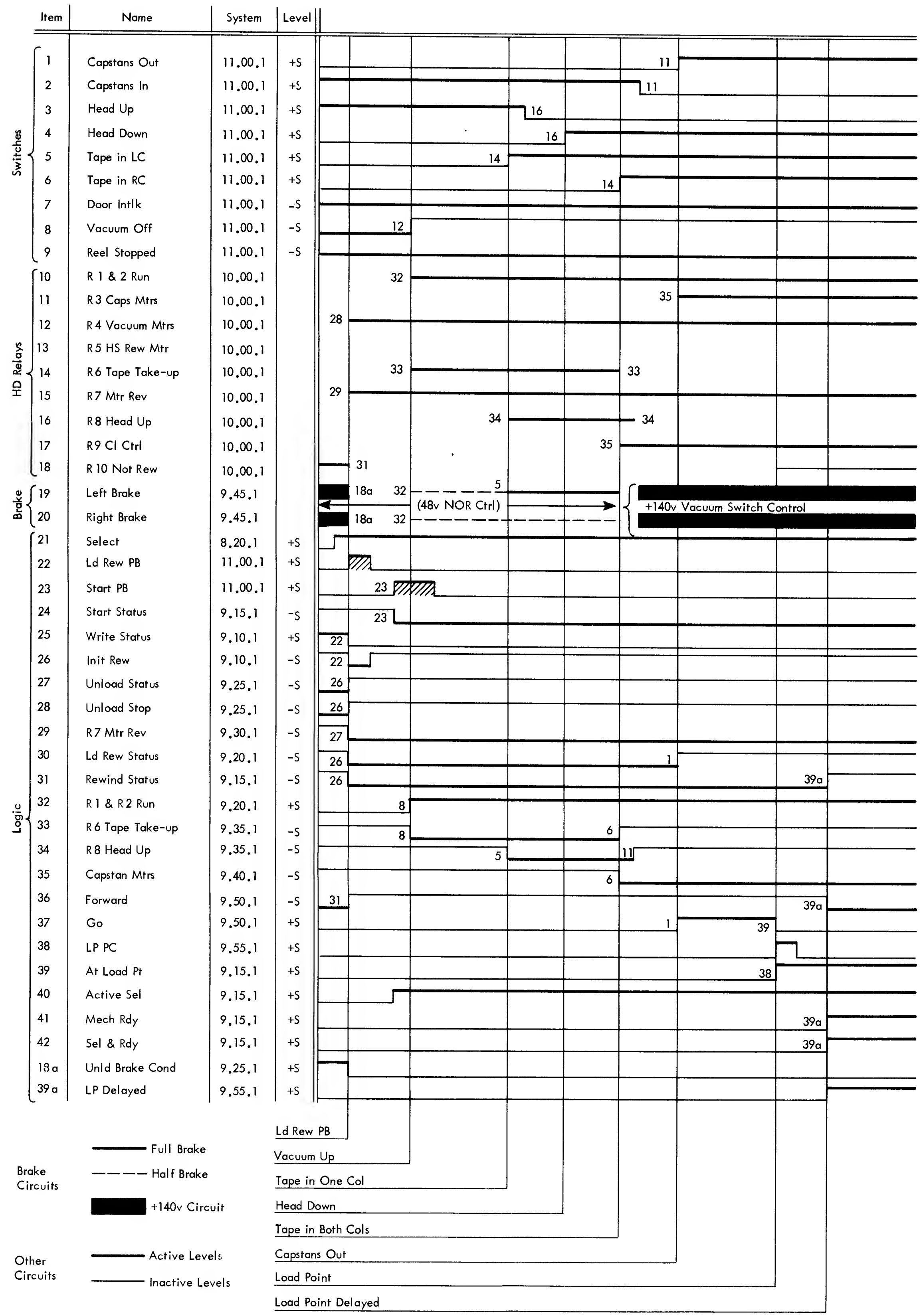
The head motor trigger is turned on by the output of the tape take-up motor trigger mixing with tape in one column and R7 motor reverse (Systems 9.35.1). Note that the head does not start down until the tape has been lowered into at least one of the columns. This condition assures that the tape is properly positioned across the transport area, and will not be pinched when the head is lowered. The head motor continues to run until the head down switch closes, tape has entered both columns, and the capstans have started turning.



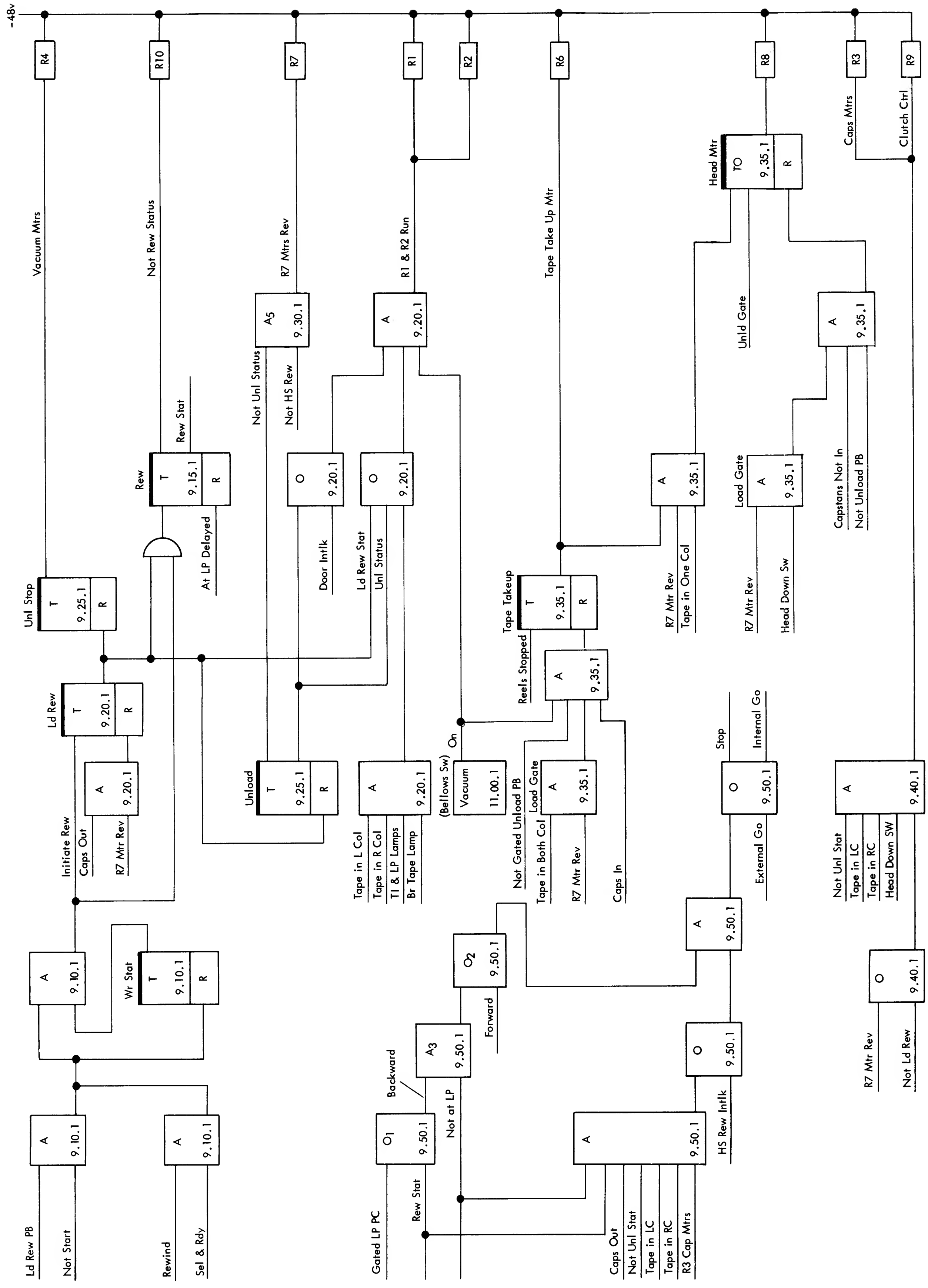
• Figure 80. Load-Rewind Flow Chart (Sheet 1 of 2)



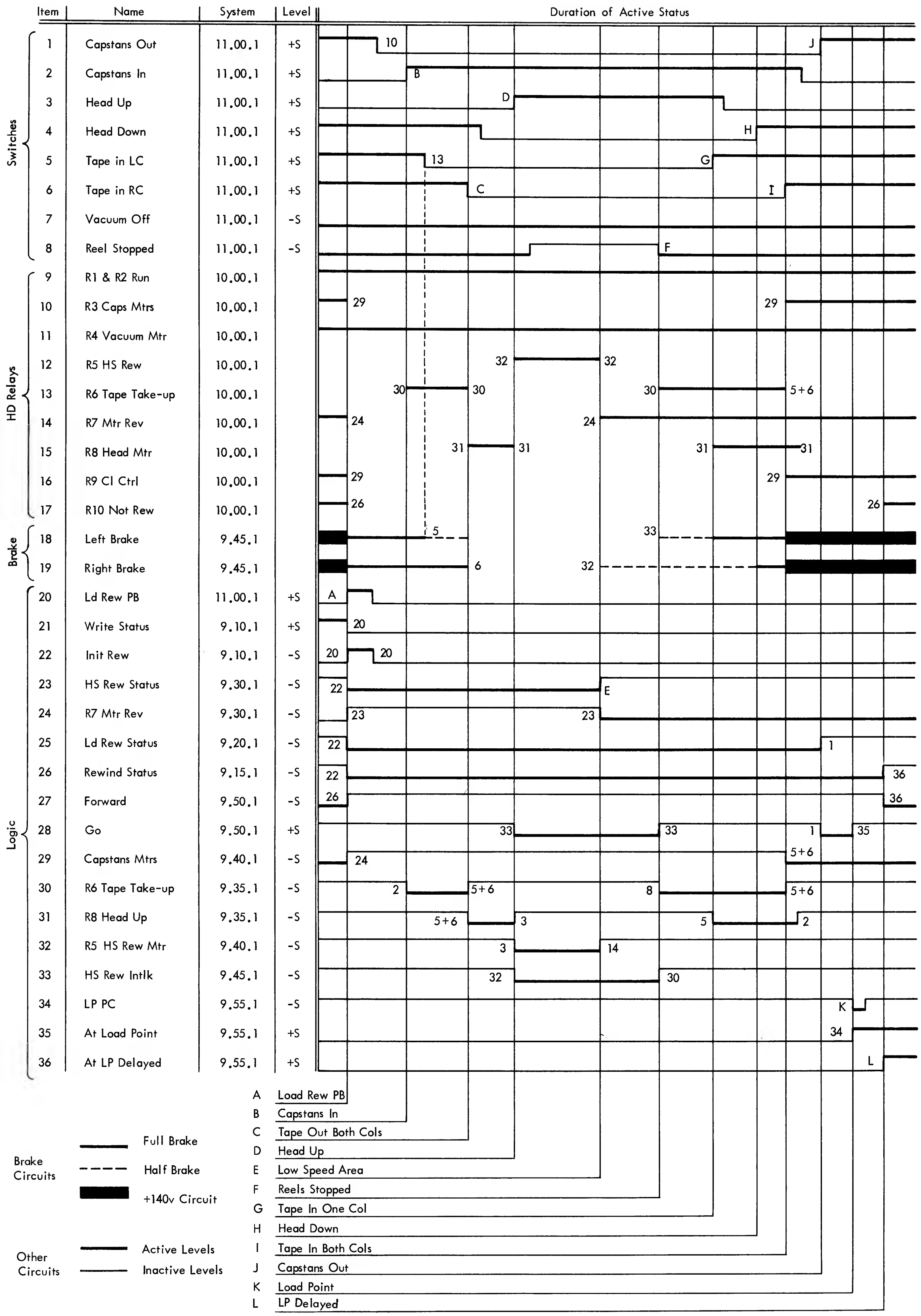
• Figure 80. Load-Rewind Flow Chart (Sheet 2 of 2)



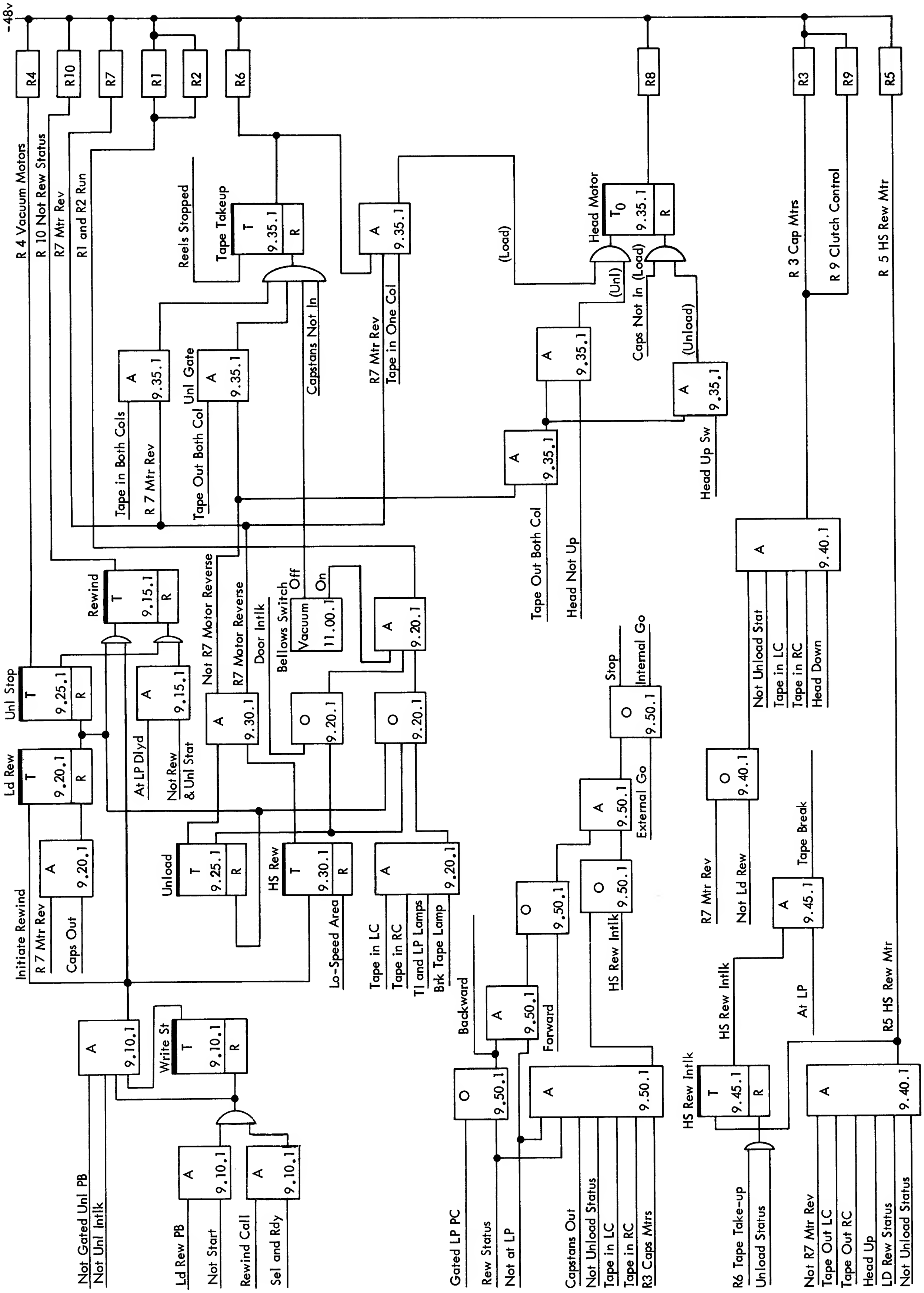
• Figure 81. Load-Rewind Sequence Chart (Low Speed)



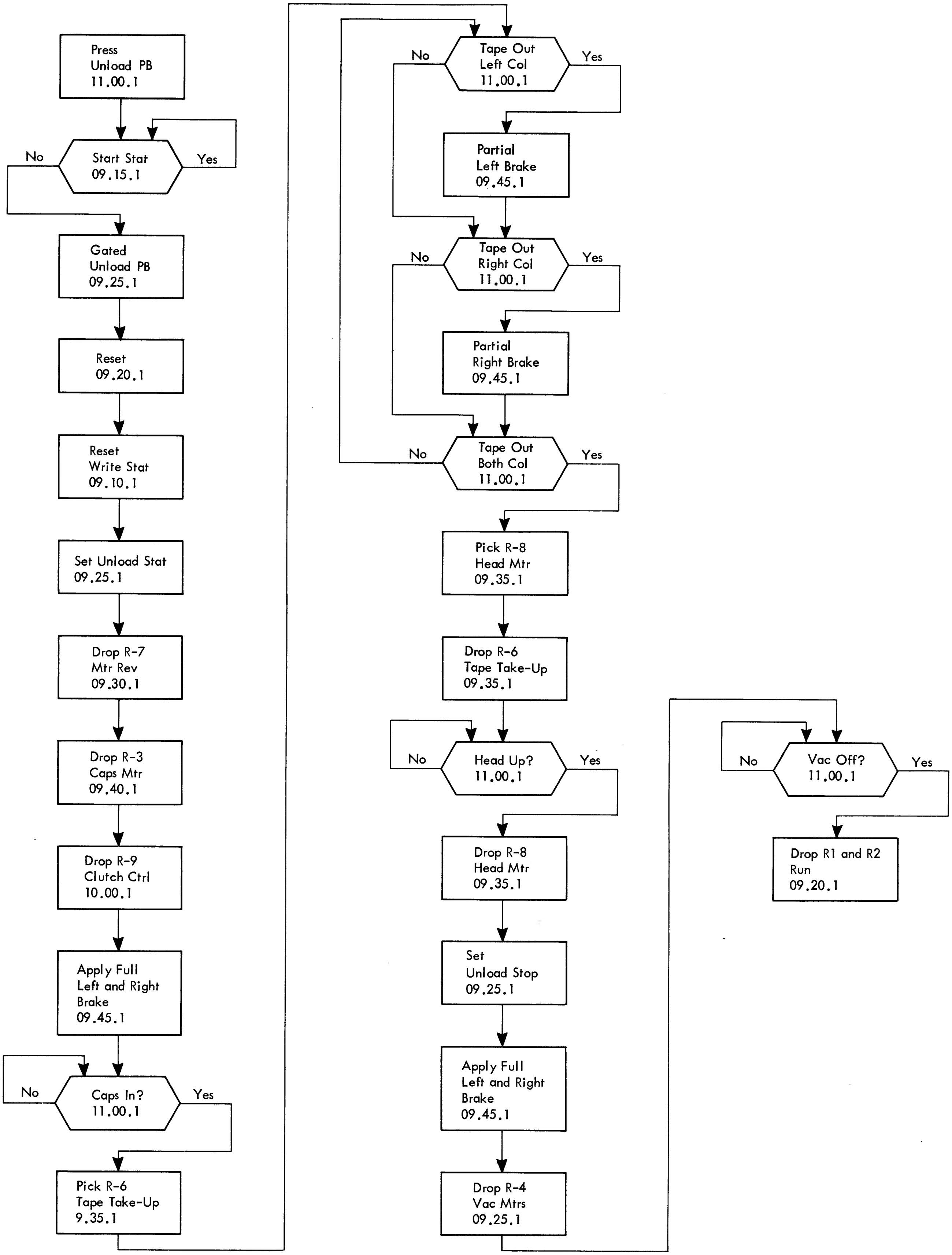
• Figure 82. Rewind and Load-Rewind Condensed Logic (Low Speed)



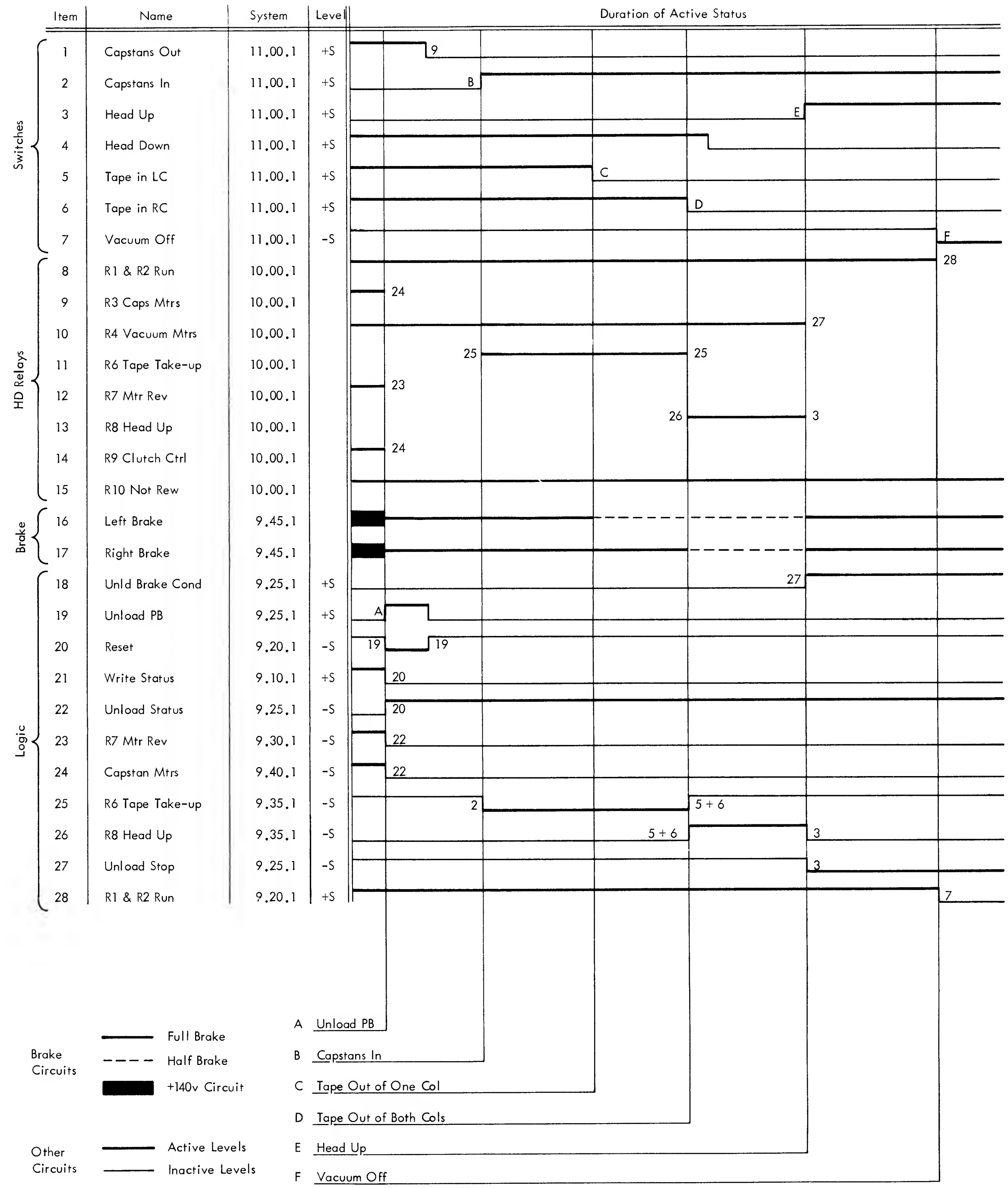
• **Figure 83. Load-Rewind Sequence Chart (High Speed)**



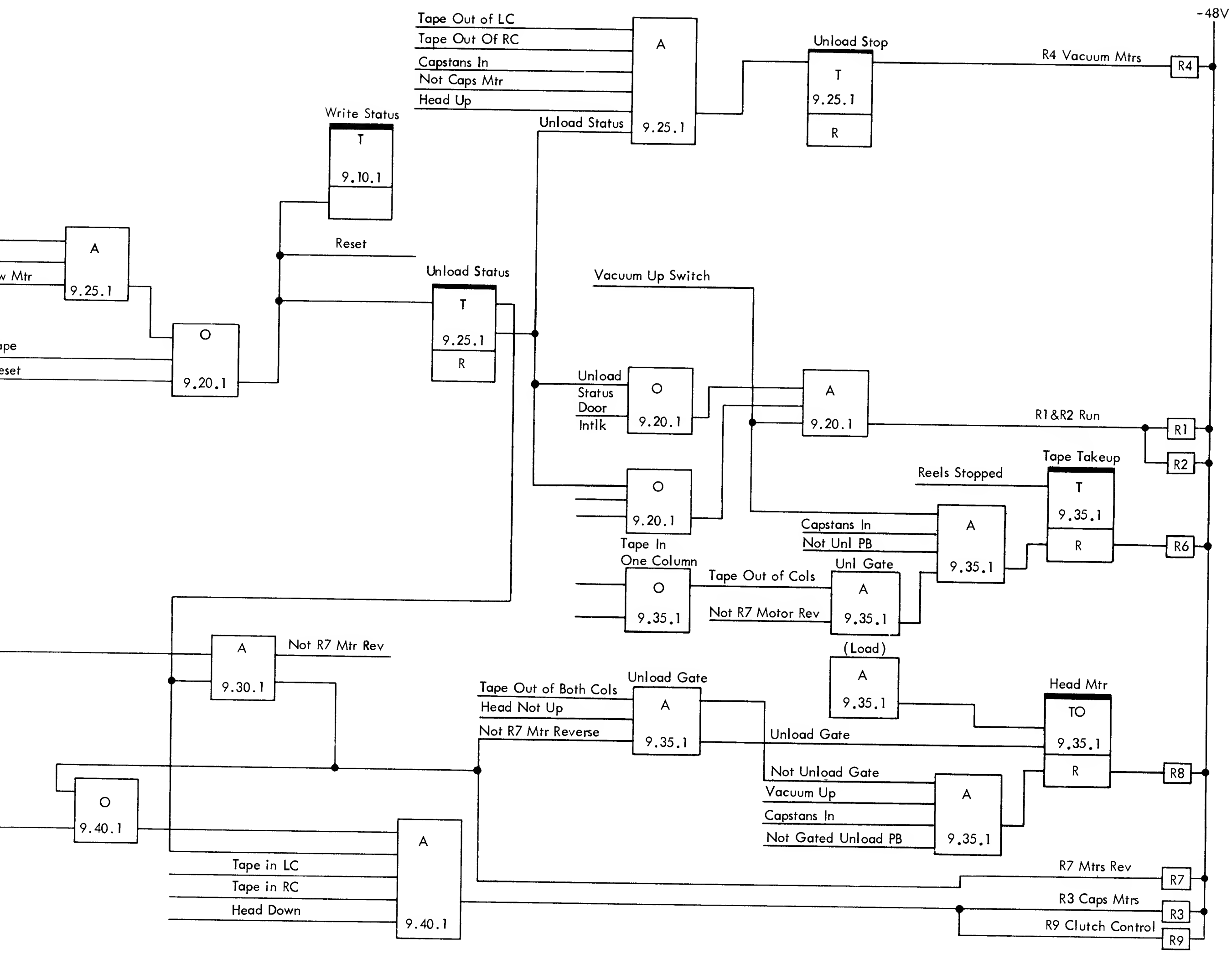
• Figure 84. Load-Rewind Condensed Logic (High Speed)



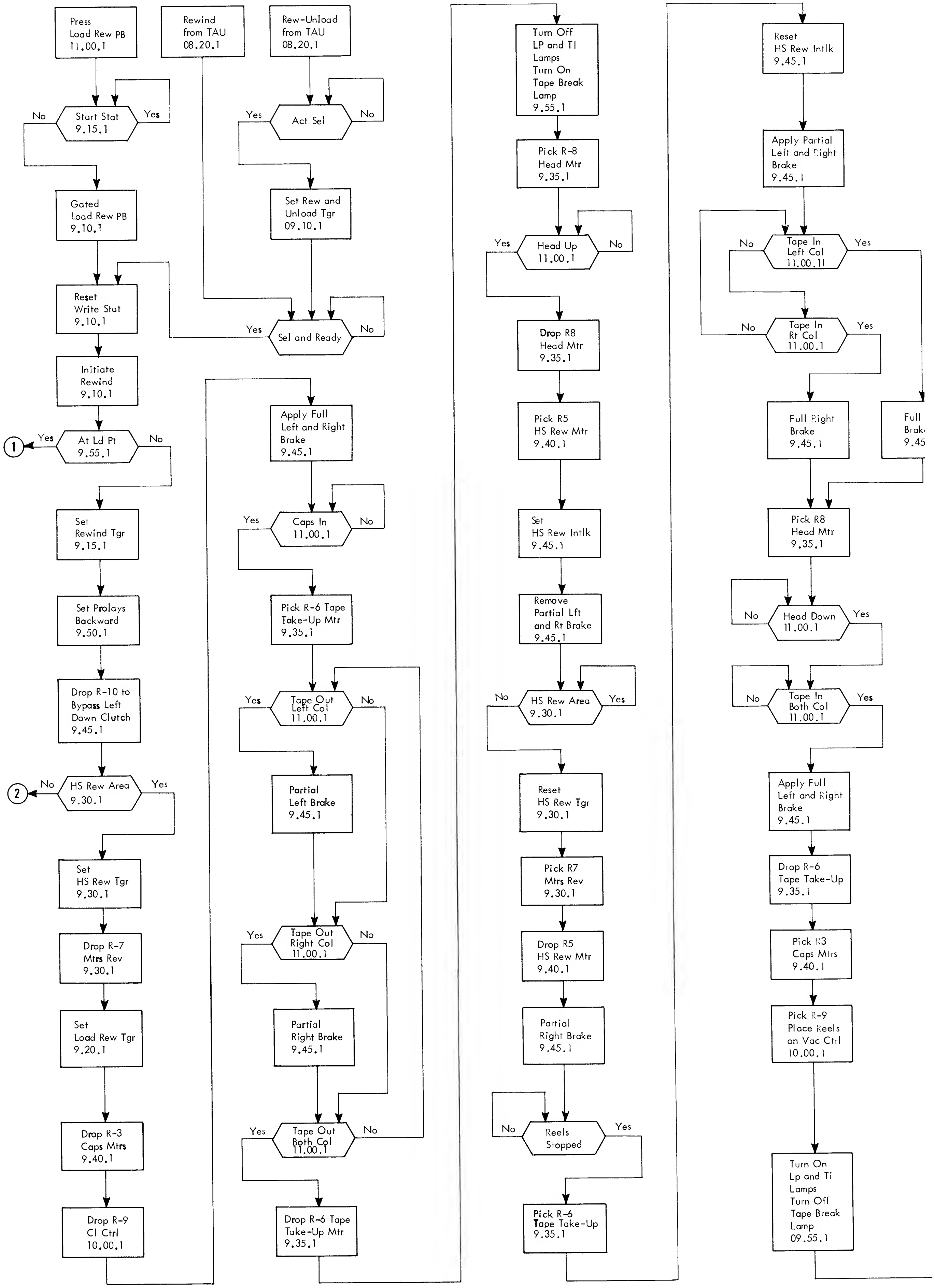
• Figure 85. Unload Flow Chart



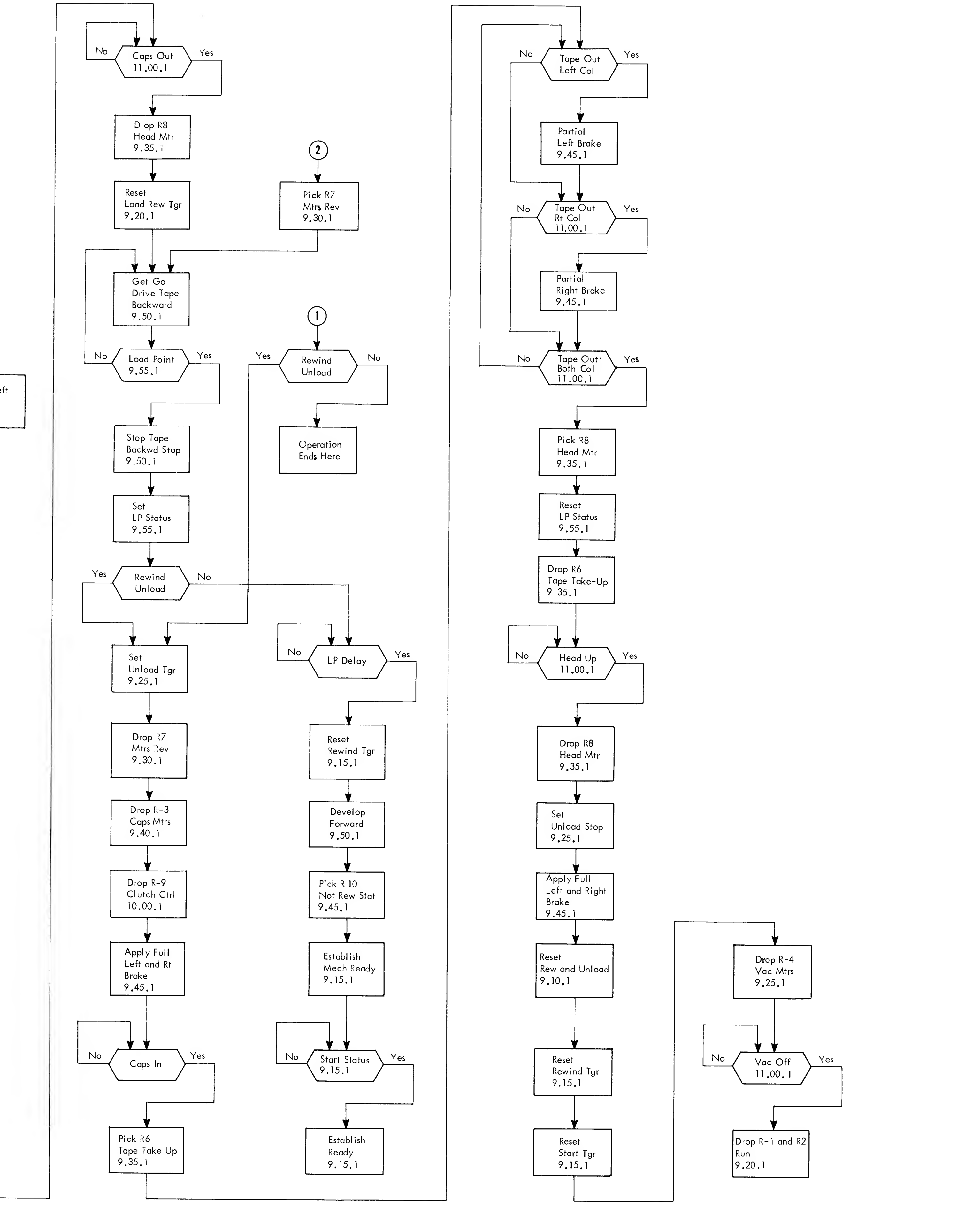
• Figure 86. Unload Sequence Chart



87. Unload Condensed Logic



• Figure 88. Rewind and Unload Flow Chart



Caps Out 11.00.1
No
Yes
Drop R8 Head Mtr 9.35.1
Reset Load Rew Tgr 9.20.1
2
Pick R7 Mtrs Rev 9.30.1
Get Go Drive Tape Backward 9.50.1
Load Point 9.55.1
No
Yes
1
Rewind Unload
Yes
No
Stop Tape Backwd Stop 9.50.1
Operation Ends Here
Set LP Status 9.55.1
Rewind Unload
Yes
No
Set Unload Tgr 9.25.1
LP Delay
No
Yes
Drop R7 Mtrs Rev 9.30.1
Reset Rewind Tgr 9.15.1
Drop R-3 Caps Mtrs 9.40.1
Develop Forward 9.50.1
Drop R-9 Clutch Ctrl 10.00.1
Pick R 10 Not Rew Stat 9.45.1
Apply Full Left and Rt Brake 9.45.1
Establish Mech Ready 9.15.1
Caps In
No
Yes
Start Status 9.15.1
No
Yes
Pick R6 Tape Take Up 9.35.1
Establish Ready 9.15.1
Tape Out Left Col
No
Yes
Partial Left Brake 9.45.1
Tape Out Rt Col 11.00.1
No
Yes
Partial Right Brake 9.45.1
Tape Out Both Col 11.00.1
No
Yes
Pick R8 Head Mtr 9.35.1
Reset LP Status 9.55.1
Drop R6 Tape Take-Up 9.35.1
Head Up 11.00.1
No
Yes
Drop R8 Head Mtr 9.35.1
Set Unload Stop 9.25.1
Apply Full Left and Right Brake 9.45.1
Reset Rew and Unload 9.10.1
Reset Rewind Tgr 9.15.1
Reset Start Tgr 9.15.1
Drop R-4 Vac Mtrs 9.25.1
Vac Off 11.00.1
No
Yes
Drop R-1 and R2 Run 9.20.1

As soon as the capstan motors start turning and extend, +S capstans in switch goes minus to reset the head motor trigger, dropping R8.

As soon as tape is down in the columns, the capstan motors (Systems 9.40.1) can rotate and extend themselves in line with the prolay idlers. These conditions now obtain: head down, tape in right and left columns, not unload status, and R7 motor reverse; therefore, capstan motors becomes active and picks relay 3.

At this point, relay three (Capstan Motors, Systems 9.55.1) turns off the tape-break lamp and turns on the load-point and tape-indicate lamps in preparation for recognizing load point during rewind.

Relay nine (Clutch Control, Systems 10.00.1) picks with relay three (Capstan Motors) and transfers clutch control from the 48-volt NOR logic to the +140-volt vacuum column switch circuits. (See the section "Magnetic Clutch Control.")

As the capstan motors begin to turn, the capstans extend into the columns and the capstan out switches close. These two switches in series turn off the load-rewind trigger (Systems 9.20.1), signalling the end of the loading phase of the operation.

The rewind phase now can begin. It consists primarily of driving the tape backward until load point is recognized. Rewind status has previously established backward (not forward) internal (Systems 9.50.1). Rewind status, mixing with the following logic, brings up go internal: not at load point, tape in left and right columns, and both capstans out and running; the final condition is capstans out. Backward go (Systems 9.50.2) energizes the left-go and right-neutral prolay combination to produce the required motion. For a further explanation of prolay logic, see the section, "Prolay Operation."

When the reflective spot passes under the load-point photocell, a ten-μs pulse is generated by the photo amplifier (Systems 9.55.1). The rise of this pulse, mixing with not forward and go, develops gated LP PC. Gated LP PC turns on the LP status trigger and activates AT LP. AT LP drops GO (Systems 9.50.1), and the prolays assume backward stop status to stop tape motion.

AT LP delayed goes positive about five ms after AT LP is activated. Activating this line resets the rewind status trigger (Systems 9.15.1), and returns the tape unit to forward stop status. The five-ms delay insures that tape motion has completely stopped before the prolays are switched from backward stop to forward stop status.

Circuit Description—High Speed (Figures 80, 83, 84, 92)

At the beginning of the operation a test was made (Systems 9.30.1) to determine if a high-speed rewind was necessary. The high-speed rewind sensing circuit essentially removes the reset condition from the high-speed rewind status trigger so that it can be set by initiate rewind. The trigger, turned on, blocks activation of R7 motor reverse, preventing the pick of R7 and acting as a control over subsequent circuit operations.

Before the opertion can proceed, another test must be made to see if tape must first be unloaded or if it is already out of the columns and ready for an immediate high-speed rewind. Because tape is in the high-speed area and loaded, the capstan motors must be stopped, tape must be removed from the columns, and the head raised before the high-speed rewind motor is energized. If R7 motor reverse is inactive, the R3 capstan motors circuit is blocked (Systems 9.40.1), the capstan motors are stopped and both capstans are spring-returned out of the path of tape.

When the capstans have retracted, the tape take-up motor can be energized (Systems 9.35.1). The tape take-up and head motor triggers are both held reset whenever the capstans are not fully retracted. Removing tape from both columns turns on the head-motor trigger, resets the tape take-up trigger, and drops R6. The head motor continues to run until the head-up switch closes and resets the head-motor trigger. Because R7 (motor reverse) was not picked, both the head and tape take-up motors run in their normal direction during an unload operation.

At this point, R5 high-speed rewind motor (Systems 9.40.1) is activated by the logical conditions: not R7 motor reverse, tape not in left and right columns, head up, load-rewind, and not unload status. Relay five (High-Speed Rewind Motor, Systems 9.45.1) turns on the high-speed rewind interlock trigger and removes all electrical brake from both reels.

The high-speed rewind operation continues until the lamp and photocell combination recognizes less than ½ inch of tape on the machine reel (Systems 90.30.1). Light striking the cell in the finger guard resets the high-speed rewind status trigger, and in turn activates R7 motor reverse, picks the motor reverse relay, R7, and deactivates R5 high-speed rewind motor (Systems 9.40.1).

Deactivating R5 high-speed rewind motor immediately applies partial brake to the machine reel (Systems 9.45.1). During high-speed rewind, the eddy current sensing device causes the mercury switch to transfer and remain transferred until partial right brake slows reels to a stop. At this time, the counterbalance activates reel stopped and immediately turns on the tape take-up motor trigger (Systems 9.35.1). From this point, the completion of the operation is explained in the section, "Circuit Description—Low Speed—Tape Unit Unloaded."

Note that the high-speed rewind interlock trigger (Systems 9.45.1) monitors only the high-speed part of the operation, and is reset as soon as the tape take-up motor circuit is energized.

Unload

The normal unload operation raises the head mechanism and removes tape from the columns so the operator can remove the file reel. No rewinding or search for load point is involved. This is a manual operation, initiated by depressing the unload key; it requires essentially that the machine be out of ready status.

Circuit Description (Figures 85, 86, 87, 92)

The unload operation is initiated by the unload key (Systems 11.00.1). The key pulse, mixing with machine not in start status and machine not in the process of high-speed rewinding (Systems 9.25.1), produces a gated unload PB pulse. This generates a reset (Systems 9.20.1).

Any manual operation which requires tape to be moved at the head area must force the machine out of write status to prevent destroying or erasing valuable information. The reset line accomplishes this (Systems 9.10.1), turning on the unload trigger at the same time (Systems 9.25.1).

Unload status deactivates R7 motor reverse (Systems 9.30.1) and blocks the capstan motors circuit (Systems 9.40.1), assuring that the capstans are fully retracted before unloading can proceed. When relay three (capstan motors) drops, the capstan motors coast to a stop, allowing the shafts to retract. At the same time, relay nine (clutch control) drops, placing the stop clutches under 48-volt NOR circuit control.

Closing the capstans-in microswitches removes the reset controlling both the head and tape take-up motors (Systems 9.35.1). When the reels are stopped with vacuum up, they energize R6 for the tape take-up motor, and set the tape take-up motor trigger (Systems 9.35.1). After the tape is out of both columns, the head motor trigger (Systems 9.35.1) sets, energizing R8 for the head motor.

When tape is out of both columns, unload gate resets the tape take-up trigger. The head up contact resets the head trigger.

The unload-stop trigger (Systems 9.25.1) is turned on at the completion of the unload operation when: capstans are in and not running, tape is out of the left and right columns, the head is up, and it is an unload operation. The turning on of the trigger drops relay four and stops the vacuum motors. As vacuum falls, the bellows switch closes, dropping the R1 and R2 run relays, and opening the three-phase circuit to the forward and reverse clutch drive motors (Systems 16.00.00).

Special Considerations

The unload key involves functions in addition to those explained above.

Unload takes priority during a simultaneous depression of the unload and load-rewind keys by blocking the initiate rewind circuit (Systems 9.10.1). Gated unload PB suspends operation of both the head and tape take-up motors until the key is released (Systems 9.35.1). If tape spills or loads improperly into the vacuum columns, the unload key can stop the operation until it is corrected by the operator. Releasing the key allows the operation to continue.

This same circuit (Systems 9.35.1) will also reduce burning of the relay seven (motor reverse) points if an unload operation is called for during loading. Both relays six (tape take-up motor) and eight (head motors) remove power from their corresponding motors during the time that relay seven (motor reverse) is transferring. When relay seven has dropped and the key is released, relays six and eight are picked again.

The unload key, in conjunction with the reset key, can be used to immediately stop a high-speed rewind. The reset key removes the high-speed rewind status by resetting the trigger (Systems 9.30.1) and in turn dropping relay five (Systems 9.40.1). Deactivating R5 high-speed rewind motor allows a gated unload PB pulse to be generated (Systems 9.25.1). This produces a reset (Systems 9.20.1), which turns on the unload trigger. Finally, unload status produces unload brake condition and turns on the unload-stop trigger. Unload brade condition (Systems 9.45.1) immediately applies both right and left full electrical brake.

Rewind

The rewind operation is usually initiated by a programmed instruction in the CPU, and is designed to return the tape to load point. To save time, more than ½ inch of tape on the right reel forces the machine into a high-speed operation. As in any backward tape movement, file protection is brought into play, inhibiting writing and erasing. A rewind instruction presented to a tape already at load point will produce no logical operation.

Circuit Description— Low Speed (Figures 82, 88, 89, 92)

The rewind signal pulse (Systems 8.20.1) can result from a CPU instruction during on-line operation (Systems 8.00.1) or from an end-of-tape recognition during an off-line cycling operation at the CE panel (Systems 13.00.1). Either source requires that the tape unit be selected and ready (Systems 9.10.1). If select and ready

is available, the write status trigger will be reset (Systems 9.10.1), so that all write head and erase head circuits are blocked (Systems 7.10.1).

The deactivation of write status generates initiate rewind (Systems 9.10.1) and turns on the rewind trigger (Systems 9.15.1). Rewind status then brings up backward (drops forward, Systems 9.50.1) and drops relay 11 (Systems 10.00.1). Relay 11 opens the write head and erase head circuits to offer further file protection during the rewind operation.

The low-speed area condition prevents initiate rewind from setting the high-speed rewind-status trigger. Therefore, relay seven remains picked and R7 motor reverse remains active (Systems 9.30.1). R3 capstan motors remains active (Systems 9.40.1), and allows GO (Systems 9.50.1) to start moving tape backward. GO is finally conditioned by: tape in both columns, rewind status, capstans out and turning, and not unload status.

The prolay driving circuit now drives tape backward in search of load point. The load-point photocell (Systems 9.55.1) generates a ten-μs pulse when the reflective spot passes the head area. The rise of this pulse is AND'ed with go plus not forward, conditioning gated LP PC. Gated LP PC turns on the LP status trigger, which conditions at LP. At LP drops GO (Systems 9.50.1), causing tape to be stopped as the result of the prolays assuming a backward stop status. Approximately five ms after at LP is activated, at LP delayed goes positive, causing the rewind-status trigger (Systems 9.15.1) to be reset. When the rewind-status trigger is reset, the tape unit is removed from a backward status and placed in forward status (Systems 9.50.1).

The tape could initially be at load point when the rewind instruction is given. In this case, write status is reset and initiate rewind is generated (Systems 9.10.1). The rewind trigger, however, is held reset by the at load point condition. No tape movement is involved, and the net effect is the possibility of a change from write to read status.

A rewind operation occurring in a high-speed area is similar to that discussed under load-rewind.

Rewind and Unload

This operation combines the functions of both the rewind and the unload operations.

A single program instruction can rewind and automatically unload the tape ready for removal of the file reel by the operator. Unloading is a very convenient way to remove a newly created tape from the system, and to eliminate the possibility of inadvertently reusing it as a work tape and destroying its information.

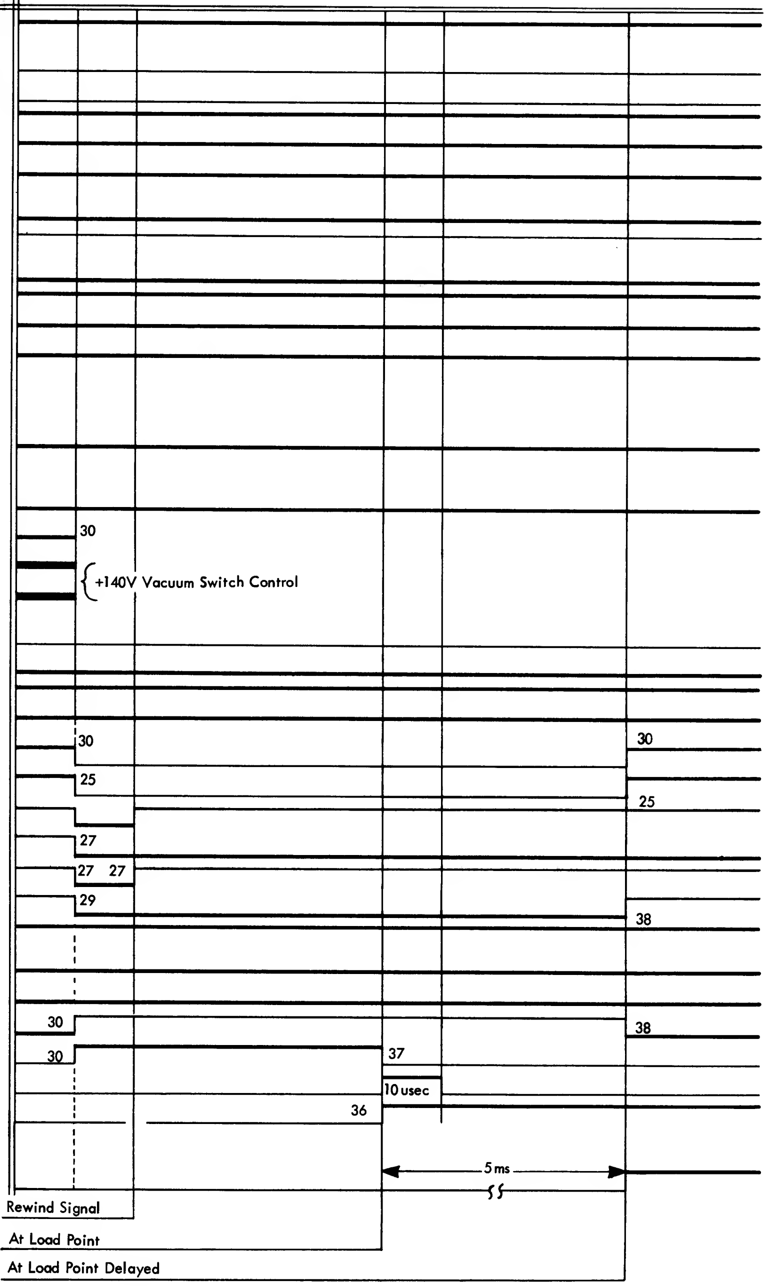
Circuit Description—Low Speed (Figures 88, 90, 92)

A rewind and unload operation originates in external program control. The signal from the controlling unit (Systems 8.20.1) mixes with active select (Systems 9.10.1) to turn on the rewind and unload trigger. (The use of active select, at this point, has no logical significance beyond that of the tape unit being selected.) This condition, mixing again with select and ready, resets the write status trigger and allows generation of initiate rewind.

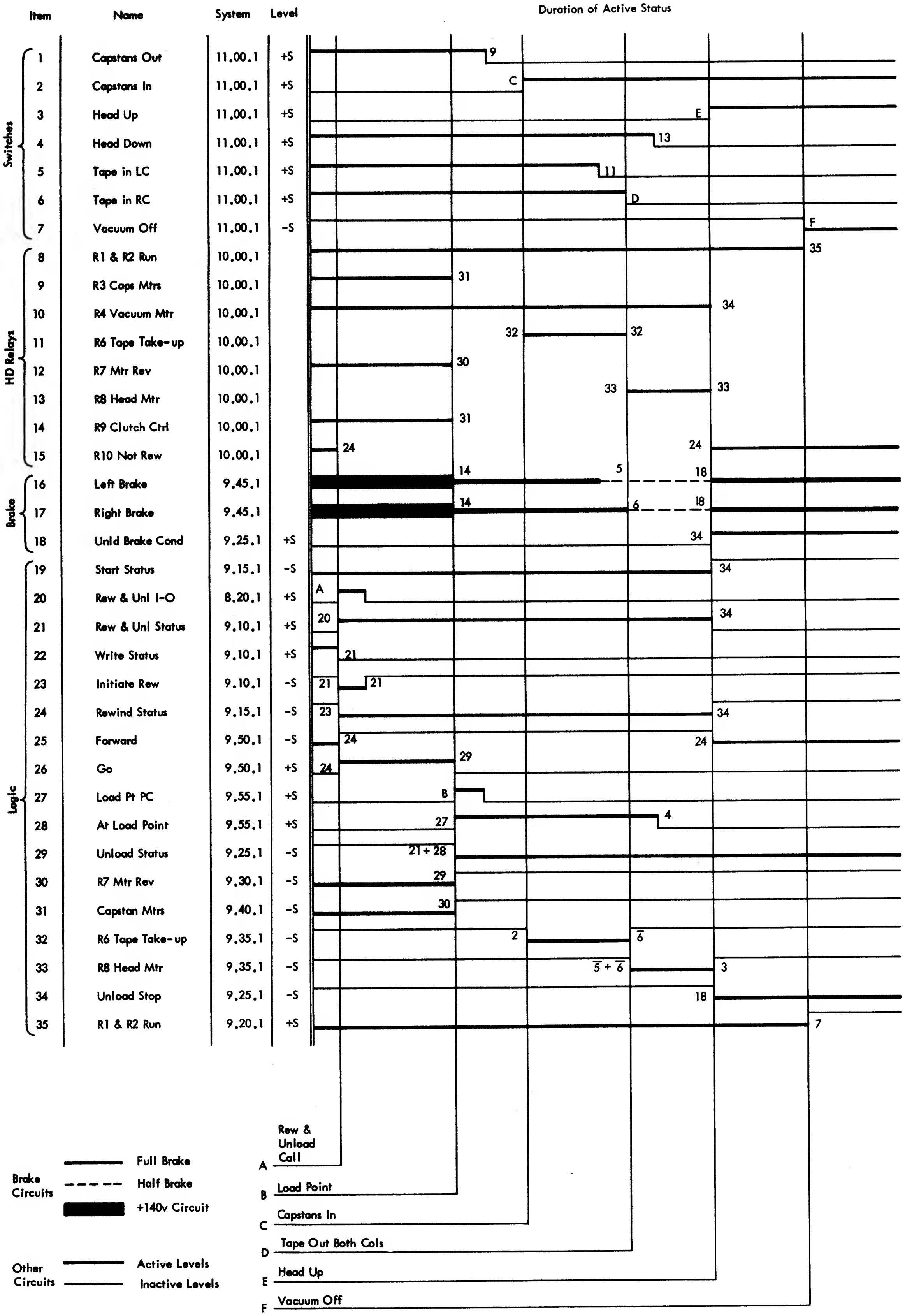
From this point the operation is the same as the normal rewinds described in earlier sections. Recognizing load point completes the first phase, rewinding. The rewind-unload trigger, turned on at the beginning of the operation, now takes over and initiates the final phase, unloading. Unload status (Systems 9.25.1) is set by rewind and unload status mixing with at load point and not R5 high-speed rewind motor. Unload status deactivates R7 motor reverse (Systems 9.30.1), starting the unloading operation. The sequence of events is the same as that covered in the section on unloading.

During a rewind and unload operation, the rewind trigger is reset by setting the unload-stop trigger. This is necessary so that a select and rewind is available to the control unit in a case where the tape unit is already at load point when the rewind and unload instruction is given.

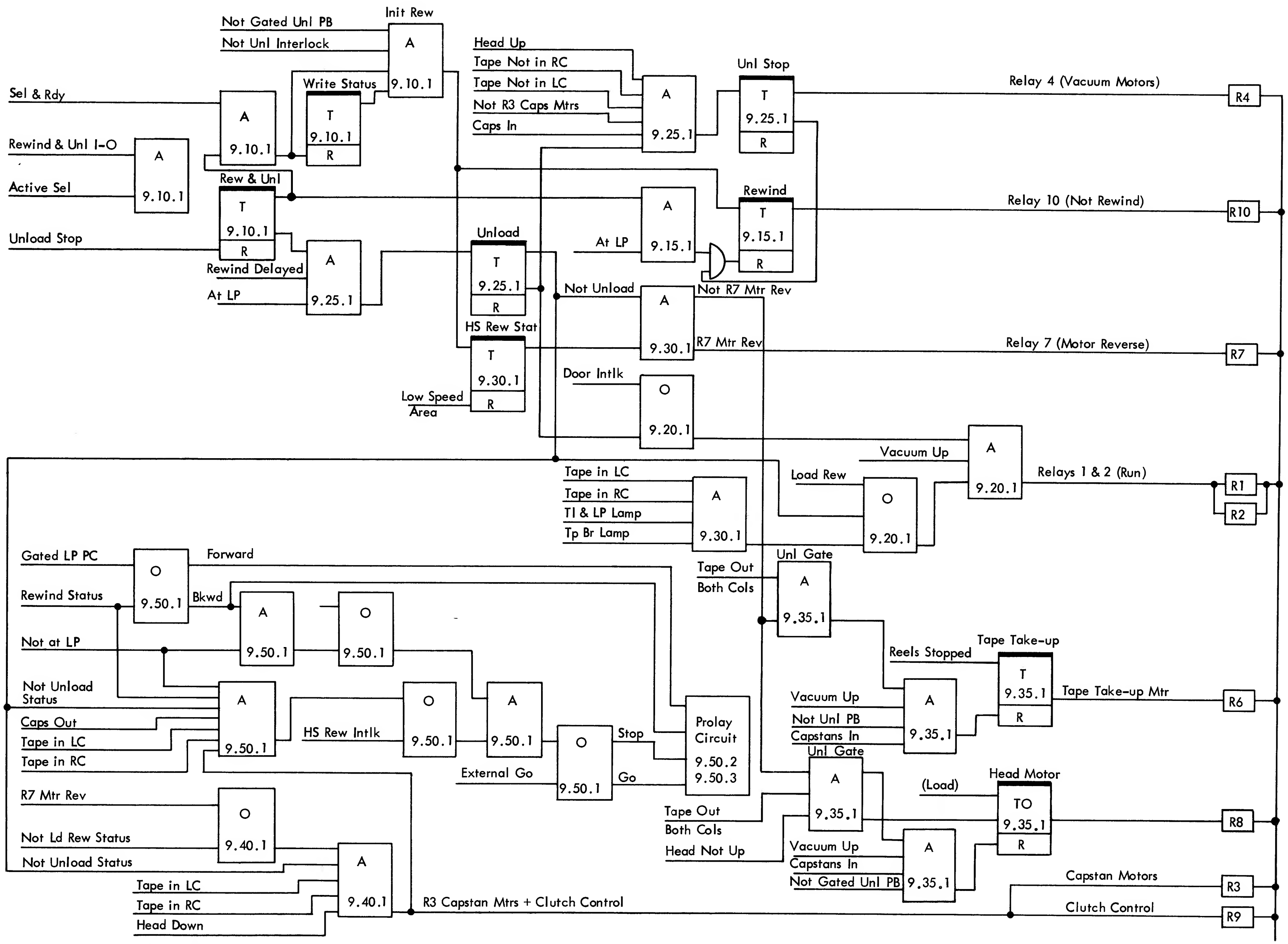
	Item	Name	System	Level
Switches	1	Capstans Out	11.00.1	+S
	2	Capstans In	11.00.1	+S
	3	Head Up	11.00.1	+S
	4	Head Down	11.00.1	+S
	5	Tape in LC	11.00.1	+S
	6	Tape in RC	11.00.1	+S
	7	Door Intlk	11.00.1	-S
	8	Vacuum Off	11.00.1	-S
	9	Reel Stopped	11.00.1	-S
HD Relays	10	R1 & 2 Run	10.00.1	
	11	R3 Caps Mtrs	10.00.1	
	12	R4 Vacuum Mtrs	10.00.1	
	13	R5 HS Rew Mtr	10.00.1	
	14	R6 Tape Take-up	10.00.1	
	15	R7 Mtr Rev	10.00.1	
	16	R8 Head Up	10.00.1	
	17	R9 Clutch Ctrl	10.00.1	
	18	R10 Not Rew	10.00.1	
Brake	19	Left Brake	9.45.1	
	20	Right Brake	9.45.1	
	21	Unld Brake Cond	9.25.1	+S
Logic	22	Start Status	9.15.1	-S
	23	Select	8.20.1	+S
	24	Active Sel	9.15.1	+S
	25	Mech Rdy	9.15.1	+S
	26	Sel & Rdy	9.15.1	+S
	27	Rewind I-O	8.20.1	-S
	28	Write Status	9.10.1	+S
	29	Initiate Rew	9.10.1	-S
	30	Rewind Status	9.15.1	-S
	31	R1 & 2 Run	9.20.1	+S
	32	R7 Mtr Rev	9.30.1	-S
	33	Caps Mtrs	9.40.1	-S
	34	Forward	9.50.1	-S
	35	Go	9.50.1	+S
	36	LP PC	9.55.1	+S
	37	At Load Point	9.55.1	+S
	38	Load Point Delayed	9.55.1	+S



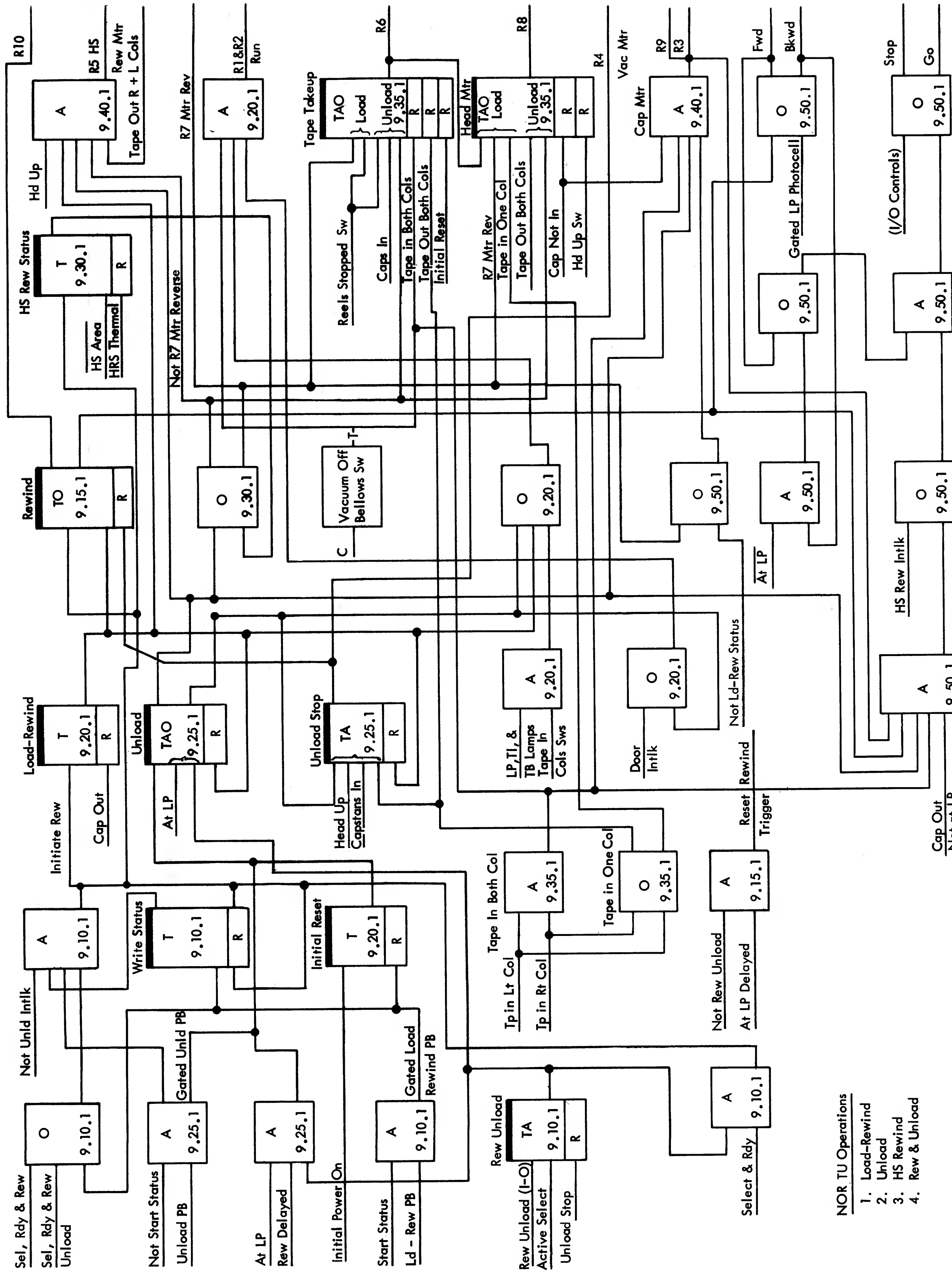
• Figure 89. Rewind Sequence Chart (Low Speed)



• Figure 90. Rewind and Unload Sequence Chart



• Figure 91. Low-Speed Rewind and Unload Condensed Logic



• Figure 92. Overall Condensed Logic

Lines Entering and Leaving the Tape Unit

Input Lines (Systems 8.00.1)

GO originates in the external control source and controls the status of the prolays.

Backward is AND'ed with "select and ready" to produce "reverse," which controls the status of the prolays. The backward line is also AND'ed with "not at load point" to prevent backspacing when the tape unit is at load point. The backward line originates in the external control.

Select Line (8.30.1) determines which tape unit is selected. The ten select lines are routed from the external control.

Start Rewind originates in the external control to start a rewind operation.

Set High Density originates in the external control to set the status of selected tape unit for high density writing.

Set Low Density sets the status of the tape unit density circuit to indicate that writing is to occur at low density.

Turn Off TI originates in the external control and is used to turn off the tape indicator trigger in the selected tape unit.

Turn On TI originates in the external control and turns on the TI trigger in the tape unit.

Rewind and Unload originates in the external control and initiates a rewind operation followed immediately by an unload operation.

Set Write Status is an input from the external control to turn on the write status trigger.

Write Pulse is a line, originating in the external control, over which timed pulses are sent to flip the write triggers.

Write Bus consists of seven lines. Information is sent over it to the tape unit to condition the write triggers.

Write Check Character originates in the external control to reset the write triggers after a record is written. Resetting the write triggers causes a longitudinal check character to be written on tape.

Set Read is an input from the external control to set the write status trigger off. This action puts the tape unit in read status.

Output Lines (Systems 8.10.1)

Select and at Load Point is generated in the tape unit and routed to the external control to indicate that the selected tape unit is at load point.

Select and Ready is routed to the external control source to indicate that the selected tape unit is mechanically and electrically ready.

Select and Not at Load Point is routed from the tape unit to the external control to indicate when tape is not at load point.

Select and Rewind is an output of the tape unit and indicates to the external control that the selected tape unit is rewinding.

High-Low Density is the output of the density circuit in the tape unit. It is routed to the external control to indicate the density at which writing is to occur (low, 200 characters per inch; high, 556 characters per inch).

Sel and TI Off is a response line from the tape unit to the external control to indicate status of the TI trigger.

Sel and TI On is a response line from the tape unit indicating the status of the tape indicator trigger.

Sel Ready and Write originates in the tape unit to indicate to the external control that the selected tape unit is ready and in write status.

Sel Ready and Read is a response line from the tape unit indicating to the external control that the selected tape unit is mechanically and electrically ready and in read status.

Read Bus (Systems 7.00.0) consists of seven lines over which information is transmitted to the external control during a read operation.

Write Echo Pulse is a line from the tape unit to the external control. The echo outputs of the seven head drivers are combined in an OR circuit and sent to the external control on the write echo pulse line to indicate that a character has been written.

Input-Output Line Specifications

Minimum voltage levels for N-type lines are: up level +0.4 volt, down level −0.4 volt. Minimum voltage levels for P-type lines: up level −5.6 volt, down level −6.4 volt.

Input

Rise and fall times for the following lines shall not exceed 1 μs. Pulse width is not specified.

Select Lines (+P)
Backward (−N)
GO (+P)

The following lines require a minimum pulse width of 1 μs:

Set Read Status (+P)
Set Write Status (−N)
Turn On Tape Indicator (−N)
Turn Off Tape Indicator (+P)
Write Pulse (−N)

The write buses must be conditioned at least 5 μs before arrival of the write pulse.

Lines requiring a minimum pulse width of 10 ms are:

Start Rewind (−N)
Rewind and Unload (+P)
Set High Density (−N)

Output

The following lines shall not have a rise or fall time exceeding 1 μs:

Select and Ready (+P)
Select and Tape Indicate Off (−N)
Select and Tape Indicate On (−N)
Select and At Load Point (+P)
Select and Not At Load Point (+P)
Select Ready and Read (+P)
Select Ready and Write (+P)
Select and Rewind (−N)

The write echo pulse requires a minimum pulse width of 1 μs.

Service Aids and Information

General Troubleshooting Hints

The possible causes for the troubles listed in the following sections were uncovered through experience on similar machines and through extensive tests on the equipment.

Biasing

Marginal checking by biasing voltage levels has been utilized on major systems for many years, not only as a useful SM aid but also as an aggravation device for intermittent machine failures.

In order to overcome a fault, in the face of urgent customer schedules, it has sometimes been necessary to bias a voltage to a point where the system will operate, then return the system to the customer.

The APJ card, which is added in EC 249870 (7090 only), is equipped with a potentiometer to set the clipping levels of the final amplifiers to 7.5%, or .6 volts with respect to −12 volts. This potentiometer may, however, be varied from approximately 3% to 18%, and as such may be utilized as a SM tool or aggravation device for elusive machine failures in the area of tape drives. Similarly the 729 tape unit preamplifiers may also serve in the same capacity because they may be varied a substantial amount above or below 8.8 volts.

In our marginal checking philosophy, however, we would not consider having the customer operate at, say 5.5 marginal volts rather than a normal 6 volts, and accept this as his normal operating voltage. Instead, the cause of his failure to run at 6 volts would be investigated during SM and corrected. This same practice should be applied to the TAU final amplifier clipping levels and the tape unit preamplifiers. It may be necessary to raise or lower these devices to allow the customer to operate. However, every effort should be made to correct the situation and return these devices to their normal operating points.

Tape System Failure

Power must remain on all tape units on line. The read bus is referenced to +6 volts. With power off, it would float around zero, altering levels to all units on the bus.

Bit Loss

This term indicates that the voltage amplitude of a signal was decreased to such a value that it could not be correctly detected as a 1-bit. Two main causes for this are:

1. An irregularity on the tape surface may lift the tape away from the read-write head when a one is being written. This reduces the resulting voltage amplitude obtained when reading. Surface imperfections can be caused by magnetic oxide clumps or backing particles.

2. The lack of magnetic coating, caused by wear at the point where a pulse is supposed to be recorded, is another source of signal drop-out.

Bit pick and bit drop troubles that are hard to diagnose can be in the connectors to the read and write head. The two connectors can be locked in position and still make poor contact.

Tape units with backward count five have a tendency to pick up or lose records while writing with error routines. To correct the failure, correct the count five problem.

Drop-Out Failures

Dirt, whether on the tape or any of the surfaces on which the tape travels, is one of the major causes of errors in a tape system. The slightest lifting of the tape from the reading head, when reading a one, has a marked effect on the signal output waveform and amplitude, resulting in a signal drop-out.

Another source of signal drop-out is trenching (a groove or trench in the read-write head). This groove is the result of extended operation, where the tape literally saws a trench in the head. Trenching is visible and is also indicated by excessive skew and dropped bits (especially the 1-bit and C-bit tracks).

Intermittent reading failures have been caused by foreign material on the tape. The following method is suggested for locating foreign material.

When the machine stops, indicating an error, mark the tape where it crosses both split idlers. Unload the tape unit and inspect the tape between the marks on the tape. The error will have occurred in this area.

When excessive skew or flutter seems to be a problem, check the split idlers for binds. A bind at this point can give the indication of excessive skew.

Noise Pulses (Pickup)

The difference between signal drop-outs and noise is that drop-outs are usually caused by the magnitude of the distance between tape and head or the magnitude of oxide discontinuity. Noise is generally a function of the rate of change of the movement between tape and head or the rate of change of the discontinuity. Similarly, noise errors arise from discontinuities in the oxide. Surface irregularities also contribute to noise.

Other sources of noise or signal drop-outs are metal chips (from the tape reel shaft, for example) which may change the reluctance of the magnetic path of the flux. Oxide clumps push the tape away from the head and also change the magnetic reluctance of the flux path.

To eliminate any errors originating from the above causes, inspect the tape drive and associated areas for accumulations of dirt, oxide clumps, or foreign material.

Door interlock switches having a poor make can cause noise on the read bus during reading or writing operations.

The following is an effective method of investigating bit pickup:

1. Write C bits on tape. (7070—use TAU CE box.)
2. Read tape. Sync on the C bus. Observe register A output. Center the pulse rise on the scope center line.
3. Jumper the final amplifier inputs together. Observe register A output for all tracks.
4. Watch for a significant variation (from the center line) from track to track, i.e. –0.4 microsecond maximum.

Noise and Ground Loops

Low signal levels and fast switching time of transistor circuits require the noise level to be very low on all ground wires and service voltage wires. It is important that there be no more than the one central grounding point on the back of the preamplifier box, right side. Two other frame ground points on the left side of the preamplifier box are for the preamplifier itself. Some of the read bus shields may also be tied to the left side.

To check for ground loops, disconnect all common ground points on the preamplifier and check continuity between the frame and any ground wire other than the preamplifier box. Be sure to check the ground buses on the transistor logic (back) gate. NOTE: Remove the signal cable. Use the RX100 scale. There should be no measurable deflection (infinite resistance). Also check the tape unit signal cables for shorts to ground.

Each shield is separated from the others throughout the signal cable, the cable shoe, and the receptacle in the tape unit. They are tied together at one point *only*, the top back of the preamplifier box. They are also tied to frame ground at this point.

Electrical Noise

Electrical noise often results in false tape indicates, write checks, and read checks. Two categories of electrical noise are: static and dynamic.

Static Electrical Noise

Static noise is produced by arcing clutch brushes, bad vacuum switches, and so on. The best way to check out the entire system for static noise is to read erased tape. The following describes how to create an erased tape for different systems. (Set all tape units to the same address.)

1. 7090—Enter a continuous WRS from the CPU console keys.
2. 7080—On CE panel, set instruction selection to skip, and the multicycle switch on.
3. 7070/7074—Use the TAU box. Set the bit switches off; nothing will be written on the tape.
4. 1401/1410—Turn all bit switches off on the CE panel, and write from the panel.

Read the tape using the CE console. The read clock should never start unless there is sufficient noise in a unit to cause a bit to appear in the A (high) register. Normally any noise generated in the unit appears as bits coming into the B (low) register. By process of elimination, a particular unit or units can be picked out as causing the problem. On a normal system that is relatively free from noise, a few isolated bits may be picked up over the length of a tape. However, as long as no unit has more than three random pickups per full feel, make no concentrated effort to locate the noise.

Once a unit is found to be noisy, use the following procedure to determine the cause:

Scope Setup

1. Use a 10:1 probe with a short ground lead.
2. Connect the probe ground to the DC ground laminar bus near the level to be tested. Use only the probe ground for grounding. Do not use a separate long ground lead.
3. Connect the probe to the level to be checked for noise. (A scope hood makes viewing easier.)

Scoping Points

Two areas of the tape unit should be scoped for noise:

1. The read bus. Noise on the read bus can get through the final amplifiers and give read or write checks. In general, noise amplitude should not exceed feed-through specifications (0.4 volts).

The width of the noise pulse as well as the amplitude determine whether or not the noise will be accepted by the final amplifier. Narrow pulses (less than 2 μsec wide at the base) of higher amplitudes will not normally be accepted by the final amplifiers. They are, however, undesirable and should be eliminated.

2. The back panel logic gate. Make sure that noise is less than 100 mv at frequencies below five mega-

cycles and less than 1 volt at frequencies above five megacycles between the following points:

A16J and F16J	+12 volts and ground
+6 volts and ground	−12 volts and ground
−6 volts and ground	

Any other two points where noise is suspected.

The most common sources of noise are the clutch brushes and vacuum column switches.

To check the column switches, manually put the tape loop in the column near one of the vacuum switch ports. Now, turn the reel slightly to cause tape barely to operate the switch; the switch will oscillate. Scope either at the read bus or the back panel for noise. Check each vacuum switch in this manner.

To check for clutch brush noise, activate the clutch as if tape were being dumped or taken up. Turn the reel until tape is beyond the vacuum port, and hold there. For example, to check the left down clutch, move the tape above the left column upper port, and hold. Check the back panel and read bus for noise. Check all four clutches in this manner.

Whereas clutch brushes and vacuum column switches are the most common sources of noise, remember that noise can come from defective switches on the tape operator's panel, defective capstan–in micro-switches, or from relay operation. If noise is a problem, explore all possible sources.

Dynamic Electrical Noise

Dynamic noise predominantly causes write errors; and results from peculiarities of the read-write head or tape, for example:

1. Base line shift. This should not exceed 0.4 volt.
2. Improper positioning of the erase head. The erase head should not touch tape. The front of the erase head and the rear of the erase head should be at the same distance from the tape.
3. H-shield adjustment. The H-shield should have the three-spring improvement installed, and should be correctly positioned for minimum feed-through.
4. Metal or Mylar particles on tape. Particles on tape cause bit pickup. If this is the problem, degauss the transport.

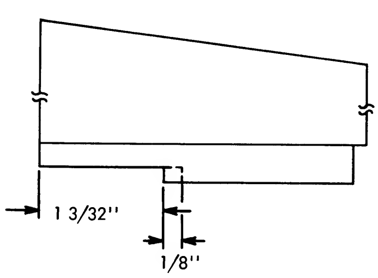


Figure 93. Upper Decorative Cover

Select Line

There have been several instances where a particular tape unit has produced excessive errors, depending upon its physical location on line. It performs properly only if it is the last machine on the line, with the signal line terminating shoe installed. In any other line position, it produces excessive read-write errors.

Magnetic clutch noise, coupled to the select line, gets to the read buses and results in highly intermittent errors. Two known causes are:

1. Unsoldered select switch (shield) common.
2. Select lines improperly wired to the select switch from the TC. A floating shield condition may exist.

A high frequency noise pulse, at least four volts peak to peak when the clutches are switched, may be found on the read buses, read gate, select line, voltage buses, and ground. Noise pulses on the select line should be less than two volts peak to peak, less than 0.3 to 0.4 μs in width, and over one megacycle in frequency.

Magnetic Clutch Brushes

Noise from magnetic clutch brushes causes excessive read and write errors, and may cause false tape indicate. The condition can usually be observed by writing or reading all zeroes on the tape drive tester while observing the read bus for noise. Sources are:

1. Contact resistance in early brush block assemblies. Resistance builds up between the brass contact strap and the steel spring. Burnishing the strap and the spring will reduce the resistance, but is not considered a permanent fix. New brush block assemblies contain a pigtail secured to the brush at one end and soldered to the brass strap on the other.
2. Arcing between the brush and commutator ring. Install diode resistor assembly, P/N 362131, across each of the six brush blocks, to minimize arcing and electrical noise. See 729 CEM 101. Be sure that slip rings are free from dents and scratches.

Slip rings can be burnished with crocus cloth, or by an emery polishing stick, P/N 450503. Brushes can be refaced by passing crocus cloth between the brush and the slip ring. *Cleaning fluid and lubricants should not be used.* Use a clean dry cloth to clean the slip ring after it has been burnished. Brushes that are unevenly worn or chipped should be replaced. Make sure that the brushes are squarely aligned and tracking in the center of the slip ring.

In extreme cases a squeal may be audible evidence that a brush is chattering on the slip ring. Observing the read bus will reveal large spikes coinciding with the audible noise. Action described in (1) and (2) above will minimize, if not eliminate, the electrical noise.

False Noise Records

False noise records can occur because of improper filtering of a vacuum column switch, usually caused by broken leads on the filter assembly. To check for this, place the tape unit in read status with the capstan motors disconnected. Manually position the tape so that it oscillates about one of the sensing ports.

Observe the read bus for transient noise pulses, at the same time lightly vibrating the vacuum switch cover. Check all switches in this manner.

Check for faulty bypass capacitors or diodes.

Information Written in the Inter-Record Gap

A situation exists whereby the customer can create output tapes having from one to twenty-five legitimate characters in the middle of the inter-record gap. This can occur if a customer, while generating one or more tapes, encounters an error and attempts to restart the program by the following method:

1. Press reset and load-rewind keys on tape units.
2. Restart program.
3. Read tape and position it to error location.
4. Proceed to write tapes.

Writing in the IRG occurs because, when the reset key was depressed, the drive went from write to read status, and the normal "write forward before rewind/backspace" did not take place. Without this write forward operation, approximately ⅛ inch of tape (the space now occupied by the IRG) will not be erased because of the physical distance between the read and write heads. The quantity of characters remaining in the IRG will depend on the processing of the tape prior to this run.

The procedure of manual load-rewind instead of programmed rewind is now considered an illegal operation.

If write status remains up while reading a record from tape, bits are written in the inter-record gap.

Erasure of Extraneous Bits in the IRG

Occasionally a customer may need to regenerate an output or master tape containing bits in the gap that cause an uncorrectable read error, and loss of a good record. Useless rerun time may be prevented by:

1. Marking the area of tape where the uncorrectable error was encountered.
2. Unloading the tape and developing the area in question using the bit viewer.
3. If the trouble is bits in the gap, erase them with a very small bar magnet or magnetized screwdriver. Rub the oxide side of tape, in the gap area, being careful not to erase good record information on either side.

   This procedure removes the iron filings and demagnetizes the tape at the IRG, eliminating the flux change representing the extraneous bits.
4. Clean the tape thoroughly and test for results.

Intermittent Read Bus Noise

Magnetic clutch brush wires should be dressed away from clutch pulleys. If the wires are allowed to drag on the pulleys, the insulation will wear through. This condition can be a source of intermittent read noise.

Load-Unload-Rewind Failures

Head Binds

If the head binds in the up position, readjust the head-up switch so that the head opens less. If the head binds in the down position, check the inside of the casting to insure that there are no machining burrs. Also check the friction clutch on the motor for cleanliness and tightness.

If, after EC 252530 has been installed, the head does not close properly when loading, file or grind down the section of the stop that prevents the head from closing properly. This also insures that the head is not subjected to undue strain while loading or unloading, reducing the possibility of mechanical skew shifting.

Felt Pad Lubrication

A relatively fast method for lubricating the upper and lower pads in the head raising linkage is:

1. Remove the upper decorative head cover. With the head up, the lower felt pads on either side of the driver worm gear are accessible.
2. Apply IBM 6 oil to the pads by putting several drops on a screwdriver tip and touching it to the pads.
3. Lower the head manually. With the head down, the upper felt pads can easily be seen between the tape head and frame casting. They are located approximately 60° down and back of the opening created with the head down and the decorative cover removed.
4. Apply IBM 6 oil to the upper felt pads in the same manner as to the lower felt pads.
5. IBM 70 grease also can be applied at this time, if needed, to the driven gear in the head raising mechanism.

Load Failures

A failure on load-rewind operation may be corrected by adjusting the bellows switch.

A loose manifold on one drive may cause tape to spill in the column.

A loose connection on the tape break lamp causes loading failures.

In cases where tape billows out upon loading into columns after high-speed rewind, check the rewind idlers and split idlers. The idlers must be absolutely free-running with no binds. End play of 0.001 inch is allowable on the rewind idlers.

Other causes of load failures are:

Load point photocell has low dark resistance.

Friction clutch compression spring causes head to bind.

Vacuum column switch transfer strap binds or is cracked.

Head-down microswitch is loose.

Magnetic clutch brush blocks are loose.

Magnetic clutches are leaking powder.

Load point lamp is burned out.

Head cover is binding.

Tape reel is not seated properly.

Vacuum leaks.

Tape chips are in column.

Unload Failures

Tape too tight at the end of an unload can be caused by the one-half brake adjustment.

A bellows switch that is out of adjustment causes tape to break at the end of an unload operation.

Other causes of unload failures are:

Binding capstan shafts.

Capstan sensing switches out of adjustment.

Magnetic clutches leaking powder.

Weak tension on clutch commutator brushes.

Dirty commutator rings.

Rewind Failures

When the tape unit goes into a high-speed rewind but the high-speed rewind motor fails to start because of excessive drag on the reels, check the clutch demagnetizing circuit and check for binds in clutch shafts (no power on machine).

Tape may be raised too slowly in the right column because of a worn brush to the right-reel-up clutch.

An adjustment of one-half brake may be required to prevent tape breakage or running off the end of the tape on high-speed rewind. Check the reel clutch brushes before making an adjustment.

Wrinkled tape can be caused by a jerky stop after a high-speed rewind, just before loading the tape to go into the low-speed area.

If tape intermittently fails to stop at load point, install an additional $10\mu f$ capacitor, P/N 491316, in series with the existing $10\mu f$ capacitor on the YAW card at location A3E05 (Systems 09.55.1).

Several instances of occasional rewinding past load point have been traced to the connector at the bottom of the tape break light. The connector can intermittently short to the lower MuMetal head cover, shorting out the LP and TI lamps. Check for sufficient clearance between the connector and the head shield.

Tape Contamination

Reel Hub Knob

Metallic particles are sometimes found inside the hub. A tenacious lubricant such as IBM 24 should be applied to the knob screw to alleviate this condition.

Rewind Idlers

Loose particles may be found, resulting from the pressing of the idler on the shaft. These particles should be removed with a penknife or else they may be thrown into the system.

Tape Breakage or Damage

High-Speed Area

Brake out of adjustment.

High-speed rewind idler binding or too much end play.

Clutch (left) binds or drags. To detect this possible cause of trouble:

1. Mount a full reel of tape (with end taped down to avoid flapping) on the left reel hub.
2. Cover the high-speed area photo cell.
3. Remove the forward and reverse drive belts from their motors.
4. Initiate a rewind.

While rotating the forward and reverse clutches slowly by hand (one at a time) listen for an audible slowdown of the high-speed shaft. A spot usually in the forward clutch may be found that will slow the shaft considerably. If you can hear it slow down *without* rotating the forward or reverse clutches, the trouble is probably in the stop clutch.

DANGER: Be careful of the voltage on the clutch slip rings.

Head Area

Binding head covers: the upper head cover can damage the edge of magnetic tape, because the tape slot in the cover is not cut deep enough to provide extra clearance. An engineering change will correct this condition on production machines, but it will *not* become a field change. However, the cover slot should be extended on all machines. Rework the slot as indicated in Figure 93: extend the slot by one-eighth inch with a grinder or hack saw; finish with a fine file, making certain all burrs are removed.

Head up and down microswitches loose.

Tape cleaner bent.

Shorted Write Head Cable

If a short to ground occurs anywhere in the write cable, the write head may be burned out. Therefore, if a burned-out head is found, the write cable should be thoroughly checked for shorts before mounting a new head. Also, the cable connector clamp should be screwed onto the connector tightly before the cable is clamped. A loose cable connector clamp can greatly aggravate a worn cable condition.

Capstans

On capstan motors manufactured after September 1, 1960, and identified by suffixes LW, LX, LY, or LZ to the right of the five digit number on the name plate, the spring bushing may collapse and allow the capstan to extend too far forward, causing:

1. Contamination of the bearings or slowing of the motor because of the bushing particles. Permanent damage to the motor can result from excessive heat.
2. Possible damage to the capstan-out sensing switch assembly.
3. Inoperative machine if the capstan-out switch transfers.

The fault condition can be identified by:

1. Persistent read-write errors caused by the decrease in motor speed.
2. Noise caused by the flywheel rubbing against the switch magnet or rear oil cup.
3. Measuring the distance between the vacuum column door and the capstan while the motor is running. The distance should be not less than 1/32 inch. If trouble is experienced, remove the motor and loosen the housing screws, sliding the front bell housing forward. Do not remove the taper pins. Use a small mirror and flashlight to inspect the bushings.

In addition to the above fault, check for loose or out-of-adjustment microswitches.

Magnetic Clutches

Brush blocks loose.
Dirty commutator rings.
Powder leaking, resulting in binds.
Excessive end play in clutch reel shaft.

Columns

Vacuum leaks.
Tape chips in column.
Bellows switch out of adjustment.
Vacuum column switch transfer strap broken.
Flapper valves binding.
Column tops with rough edges.

Improper Tape Handling (Loading)

If the tape unit door is opened just after the tape has risen from the columns, causing the tape to be stopped by the capstans instead of coming to a normal stop, tape may break. Tape breakage has also been traced to poor alignment of the rewind motor. Excessive vibration within the tape unit frame during high-speed rewind makes it possible for the capstans-in switches to drop out of the circuit and cause tape breakage.

Tape Dumping Caused by Brake Clutch

Clutch powder deterioration and leakage affect clutch response and cause tape dumping in the columns. Study of the functions of the three clutches shows that the brake clutches cause tape dumping more often than a faulty up clutch.

Requirements of Up Clutch: The up clutch accelerates the reel from a stopped position to capstan speed before the tape loop can bottom in the column. The up clutch is energized when the tape loop goes below the lower vacuum port.

Requirements of Down Clutch: The down clutch accelerates the reel from a stopped position to capstan speed before the tape is pulled out of the column. The down clutch is energized when the tape loop goes above the upper vacuum port.

Requirements of Brake: The brake must respond to a condition worse than that encountered by either the up clutch or the down clutch. This condition presents itself when the direction of the tape over the head is reversed. Consider the condition where tape is told to go backward just as the tape loop passes the upper port while traveling down in the left column. At this time tape is being dumped in the column by the reel at approximately 280 inches per second (considering a full reel of tape) and by the capstan at 112.5 inches per second. The brake must stop the reel before the loop reaches the lower port. The up clutch cannot be relied upon to prevent the tape from dumping if the brake has *not* stopped the reel before the loop reaches the lower vacum port. It is most important here to distinguish between reel motion and tape motion in the column. To function properly, the up clutch must depend on the reel's being stopped by the time tape passes the lower port. Therefore, the tape going below the lower port during a tape reversal is usually due to a poor brake. A poor brake also causes tape to pull out of the column if the down clutch and the column upper port are considered.

Summary: If tape dumps:

1. While processing in one direction—check the appropriate up clutch.
2. While changing direction during processing—check the appropriate brake clutch.

Other causes of tape dumping are faulty vacuum switch bypass capacitors or diodes or dirty or slow-acting vacuum switch contacts (insufficient spring tension).

Check the following if tape is creasing:

1. All warped reels removed from service.
2. Any latch rings that do not allow tape reels to slip on and off easily have been replaced.
3. No end play or bearing roughness in high-speed rewind idlers.
4. Split guides operate smoothly, and have steady, even tension.
5. H shield free from binds.

6. Reel hubs aligned to rewind idlers and columns.

7. Reel shaft has minimum end play. (Do not over-tighten.)

8. No binds or rough spots present in the magnetic clutches, shafts, or bearings.

9. No excessive machine vibration during high-speed rewinding.

10. Proper alignment between high-speed rewind motor and coupling and the reel shaft.

11. No excessive tape curvature.

12. Proper tape storage and handling procedures by operating personnel.

13. Tape-in-column switches operating properly.

14. Sufficient tape tension maintained during high-speed rewind.

Magnetic Clutches

Causes of Clutch Failure

To check operation or to troubleshoot up or down clutch and associated relays and vacuum switches: load tape and stop immediately (to prevent dump if either clutch fails). Open the door and use the reel release key to place tape below the lower vacuum switch to test up clutch, or above the upper vacuum switch for down clutch. Unplug the reel drive motors. Hold the reel being tested and close the door interlock. Rotate the reel back and forth, being careful not to pass the vacuum switch opening (as this applies full brake). Watch the clutch brushes for arcing. Compare the feel of right and left clutches.

Dirty brushes or contact rings may work at one point and fail at another, so try rotating quickly one way, then the other, to check for momentary loss of grip by the clutch.

In troubleshooting a solid clutch failure, the reel may be held in position by a piece of cellulose acetate tape applied to the backplate while checking relay points and other sources, until clutch operation is restored.

Clutch Powder Leakage

Clutch design permits the loss of a certain quantity of powder without impairing machine operation. Loss of magnetic powder from a clutch decreases the torque capacity, and thereby the response time of the clutch. The result is that the tape loop in the vacuum column must travel farther than normal. Because this abnormal condition is visual, it can be used as an approximate clutch performance indicator.

To insure standard observations, use this procedure: when the tape unit is running continuously in either a forward or reverse direction, and with a full reel of tape first on the left reel and then on the right reel, the tape loop in the vacuum column will always be less than seven inches above the upper sensing hole. Any excursion farther than seven inches beyond the sensing holes is considered a failure. Before the clutch assembly is replaced, check the following items to determine their condition:

Vacuum column switch adjustments and resultant response.

Reel clutch contact brush assemblies for proper contact and tension.

If these items are satisfactory, the clutch assembly should be removed.

Operational Check

The following program may be used to check clutch response of a 729 NORLAY tape unit. Poor clutch response can cause tape to dump into either column. Use a full reel of tape. Key-in the following routine, selecting the appropriate unit and channel. A stop will not be initiated; consequently, this test will move a large amount of tape.

LOCATION	INSTRUCTION
0000	Write 10,000 character tape record
0001	Branch to 0001 if channel busy
0002	Backspace over record
0003	Branch to 0003 if channel busy
0004	Unconditional branch to 0000

Write Errors

Check tape.

Check ground connections on the read and write bus shielded cabling. These ground wires should stand a moderate pull without coming loose.

Check to see that the read and write bus edge connectors are not shorting against adjacent pins.

Check the ground connections on the read and write head plugs for tightness.

Check the read and write head plugs for tightness.

Compare checks can occur when the H shield does not seat properly during the load operation or creeps up during subsequent writing. This improper adjustment causes excessive feed-through. Two brass screws control lateral movement by squeezing the mounting block. The screws should be adjusted to allow free vertical movement with a minimum of lateral movement. After the shield is properly adjusted, apply Glyptal (or fingernail polish) so that the screws cannot loosen.

The upper head MuMetal shield sometimes prevents the head from seating properly; forming the shield eliminates this.

Position the upper head cover to provide clearance for the lower head cover when the head is down.

A defective delay line card can cause intermittent flipping of the write trigger. A small amount of ringing on the write pulse is normal, but an excessive amount will cause trouble. Scope the input to the delay lines and the inputs to the write trigger.

Make certain there is clearance between the prolay MuMetal cover and the lower head MuMetal cover. If they are touching the prolay, motion can be transferred to the head, resulting in skew.

Dirty contacts on R11AL can cause low voltage to the center tap of the write head, resulting in low write current and low read signals.

Miscellaneous Failures and Service Information

Photosense High-Speed Rewind

The large halo around the light beam of the new style photosense high-speed rewind lamp may make adjustment difficult. By adjusting the lamp voltage to its minimum, the halo is eliminated and better focusing is possible.

Tape Address Selection

An unused tape unit should be in reset status. Changing the address on a ready tape unit while the system is running can cause errors.

Rewind Motor Coupling

Breakage of the rewind motor coupling is usually caused by misalignment of the rewind motor and clutch shaft.

Jackshaft Clutch

The head up and/or down microswitch will not be operated at the proper time if the jackshaft clutch slips. This could cause the tape to dump or become stretched.

If this problem is suspected, clutch torque can be checked with a ×10 gram gage as follows:

1. Disconnect reel drive motors (safety).
2. Pull out door interlock switch.
3. Press load-rewind (no tape mounted).
4. Place the gram gage blade against the upper limit stop, measuring the tension required to prevent turning of the jackshaft.

A minimum reading of 300 grams is required for satisfactory clutch operation. If the clutch slips too easily, dip a tab card in cleaning fluid and pass it between clutch surfaces several times. If clutch torque is still insufficient, disassemble the clutch and stretch the spring about one and one-half times in length to increase tension.

Scope and Tester

Oscilloscope Procedure (535 and 545)

Due to inherent characteristics of tape writing and reading, jittering of displayed wave forms cannot be overcome when using delayed sweep unless internal triggering of the A sweep is also used. Normally, in the delayed sweep application, the A sweep is allowed to free run. After setting up the scope in the usual manner for a delayed sweep application, turn the A triggering to internal plus or minus. Adjust the A sweep stability and triggering level controls until jitter in the displayed wave form is eliminated.

Tester

729 NOR tape units do not contain a factory-installed tester SMS twin card. The required tester card is AWA-, P/N 373305 (Systems 13.00.1). Figure 94 shows its circuit.

Scoping

It is not necessary to use a special connector when synchronizing on the GO hub. On this jack, the inner pin and the outer ring are electrically common. The outer ring has four holes; these and the inner pin allow the use of almost any type of clip or scope tip, for example:

P/N	NAME
461086	Pincher Tip
461090	Hook Tip
461091	Straight Tip
461119	SMS Probe Tiplet
461159	Alligator Clip

Connectors

200-Position Connectors

Keeper plates can break when mating two cable halves of the 200-position open-wire low-voltage connector. To open, move both operating handles simultaneously. To close, after mechanically latching the two external cable units together, close both operating handles simultaneously.

If a keeper for a 200-position connector is broken, and no replacement is readily available, interchange the keeper with the guide on the male connector; the two parts are identical.

Early production 200-position connectors had latches that were too short. To compensate, the keeper plate was shimmed forward. On later connectors, the latch was lengthened and shimming was no longer necessary.

Occasionally one of two incompatibility problems may arise where new and old equipment is mixed:

1. Old connectors cannot be latched to newer machines. If the old connector must be used, then the machine keeper plates should be shimmed. Add a

0.016-inch thick washer, P/N 211034, on each of the four retaining screws between keeper plate and board, P/N 598688.

2. Newer connectors may mate loosely to machines with shimmed keeper plates, thus introducing a possible source of intermittent trouble. The washers should be removed from behind the keepers.

Signal Cable Termination

The interconnecting 200-position signal cables between tape units do not carry the four voltages needed for termination. The terminator block must be placed in the connector in the last unit on a bank. It cannot be placed at the end of a cable connected to that unit.

Input Contactor K3

Loose terminal screws can cause intermittent problems. Some screws may not be tightened enough to set the terminal lugs under the terminal screws.

13-Position Burndy Power Connectors

Part numbers of the various pins and sockets used in the connectors are:

LOCATION PIN NUMBER	PLUG 526516 P/N OF PIN	RECEPTACLE 526517 P/N OF SOCKET
1	535085	535084
2	535085	535084
3	535679	535084
5	535087	535082
10	535087	535082
11	535083	535086
12	535083	535086
13	535083	535086

Pin #3, ground, is ⅛" longer than others. Positions 4, 6, 7, 8, and 9 are not used. Pins and sockets listed above are available from Mechanicsburg.

Power Cable Ground Connection

The grounding pins in the power cable receptacles are longer than the other pins, to connect grounds before other connections are made.

It is possible to insert the connector with the grounding pin *one hole too low*. The connector can then be raised slightly, bending the pin and forcing the connector with the other pins correctly located. The ground pin will be badly bent. Be careful to align connectors before tightening, to avoid pin damage when connecting power cables.

Lamps and Indicators

Replacement of 55 Volt Indicator Lamps

The 55 volt indicating lamps (ready, hi/low density, etc.) can be most easily replaced by opening the drive door and swinging out the indicating light channel. Face the back of the channel, loop your finger over the top of the inside bar, and push the 55 volt bulb toward you. The lamp can then be removed and replaced from the rear of its socket. If the space is too small for your finger, a small piece of metal formed to a right angle works well.

Tape Indicate

False tape indicate can be caused by the following:

1. Variation in response of TI photocell. Selecting photocells for shortest duration may correct this.
2. Backspace or rewind received just prior to end of file reflective spot. (A TI caused by write forward before backspacing motion is legitimate.)
3. Noise, ground loops, and open grounds. These may be due to bent power or signal connector pins, sometimes not on the unit that is failing.
4. Open filter capacitors in power supplies.

Covers and Doors

Window Stops on the doors may work loose and eventually tear out completely; EC 249250 corrects this condition. One branch office temporarily solved this problem by removing the stripped 8-32 helicoil insert and installing a 10-32 × 1⅛ fillister head screw to hold the stop firmly in place.

Exhaust Fan Safety Covers (screens) may be installed by snapping the screw mounting ears over the top edge of the fan mounting ring.

CAUTION

Dress the cable away from the fan blades.

Relay and Connector Covers (safety covers) are provided for tape selection relays, on tape units with B/M 570053 (tape selection feature, EC 280100).

Rear Cover: The rear folding cover can easily be removed by lifting it from its hinges. For lengthy PM or EC activity, removal of the cover gives more work space. Be certain the cover is placed well out of the way, to prevent accidents or damaged covers.

Tape

Heavy Duty (H-D) Magnetic Tape

Concerning H-D magnetic tape, remember that:

1. IBM tape developer and transport cleaner, P/N 517960 *damages* H-D tape.
2. R-W heads must be demagnetized (AC-erased) periodically.

Use extreme caution when cleaning the tape transport area of the tape units. Cleaner must not be allowed to come in contact with the tape.

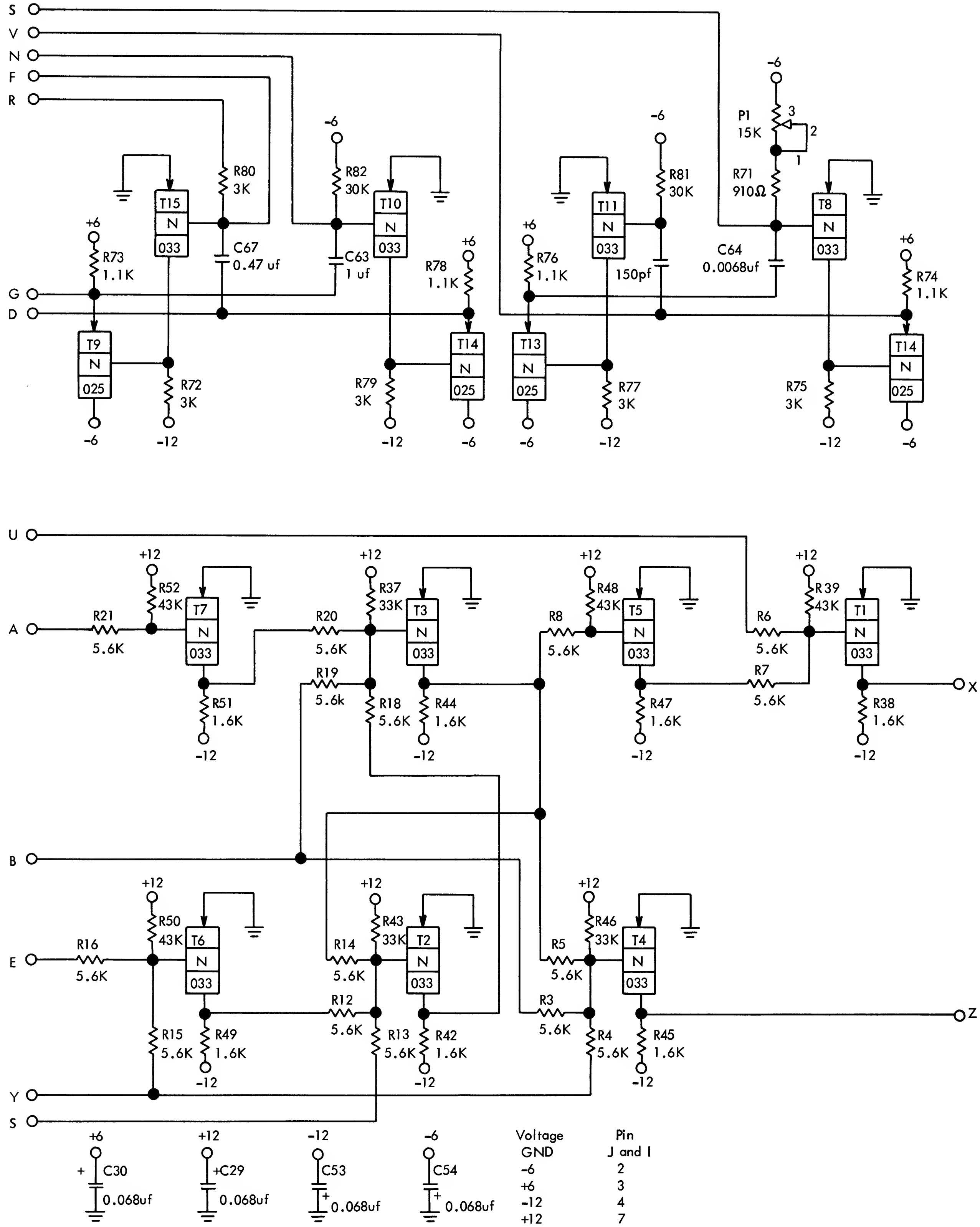


Figure 94. AWA- Card Circuit Diagram

Recent tests have proved that metal particles on tape cause read-write errors, especially on a head that is magnetized. This condition can be greatly reduced by using a degausser (P/N 451064, available in Mechanicsburg):

1. Remove magnetic tape from transport. Do not place on top of tape unit.
2. Remove decorative head cover and shields to expose front surface of R-W head.
3. Press push-button on degausser when at least 12 inches away from head, then move in slowly.
4. Hold degausser against the front surface of the head for about ten seconds.
5. Pull degausser straight out very slowly to a distance of at least 12 inches before releasing the push-button.

Degaussing should be done also if the head has been subjected to a strong magnetic field. Do not use the degausser near magnetic tape of any kind because it will erase information on the tape.

DANGER

The degausser AC line cord can short to the metal handle. All degaussers not marked "safety inspected" should be returned to Dept. 683, Endicott, marked for safety inspection. Safety-inspected degaussers will be returned or replaced.

Dynamic Check

Write checks in a particular channel may be due to a bad spot on tape. A quick check of tape condition can be performed:

1. Write continuous (all bits).
2. Scope suspected channel (sync internal).
3. The defect will appear as glitch on the pattern (Figure 95).

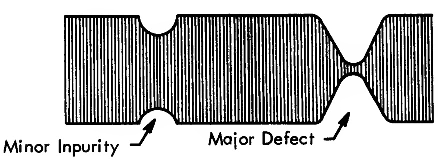


Figure 95. Tape Defects

The defect may be caused by an oxide particle, defective spot, tape crease, or by tape flutter caused by improper head wrap angle.

Tape Spilling

When loading, tape usually enters the left column first because of the large diameter of tape on the file reel. Though the tape unit is in reverse stop status at this time, the tape is not held in place between the idler and stop capstan until the head comes down. Occasionally, tape will not enter the right column sufficiently and will be pulled back out; or will trip entering the right column and spill in or out of the column. Also, the capstans can pop out momentarily, and damage tape.

Reduce the tendency to spill by reworking the vacuum column door top. File the top of the inner plate to a 45° angle so that it tends to funnel tape into the column. Installation of EC 252528B (729 CEM 93) may also correct these problems.

Tape Dumping

Reel drive motor V-belts are now notched to reduce shedding of fine particles of rubber (EC 248986 for new production machines and replacement parts). However, the notched belts stretch after a short period of operation. Loose belts cause tape dumping.

Check the tension of notched belts:

1. On all tape units in a new system, about one week after installation.
2. Within two weeks after new belts have been installed on any tape unit.

The part number of the belt, P/N 515909, has not been changed. Though the Mechanicsburg stock system automatically specifies a pair of belts when one part number is ordered, be sure to specify a matched pair when ordering. When any replacement is necessary, always replace both belts with a matched pair.

Split Records

A few cases of split or broken records have been reported, caused by loose screws on the spring type contact terminals for LP, TI, and TB photocell lamps. Poor electrical contact at these points can cause a momentary flicking of R1 (run relay).

Compatibility

In 7070 installations there may exist a problem of reading, on the 729 II's and IV's, tapes that were generated by 727's and 729 I's. The probable cause is a slow start from load point in the 729 II or 729 IV. Because tapes generated by a 727 or 729 I have their first record nearer to load point than do tapes generated by 729 II and IV (different write load point delays), reading of the first record can be affected. Temporary solutions include:

1. Raise the tape up to the upper vacuum switch in the left column.
2. Decrease vacuum for only the first record, by disconnecting a vacuum motor.
3. Change tape units.
4. In 705, 650, etc., systems that are generating tapes to be read, change the write load point delay to 114 ms, the model II write load point delay.

A slow forward start can occur also after a multiple backspace operation when the left column becomes

full of tape. For this, (1) and (2) above may help temporarily.

Density Setting Error

On 90 KC systems, the tape control density switch and the tape unit density switch must both be set to the density of the tape being read. It is possible to read tapes with these switches set incorrectly; intermittent errors will result.

Transistors

Identification and Substitution

TYPE	IBM P/N	N/P	NOTES
13	344892	PNP	1
25	318322	PNP	2
26	535441	PNP	—
28	518689	PNP	—
33	318324	PNP	3
42	369108	PNP	—
63	344891	NPN	4
75	318323	NPN	5
83	318325	NPN	6
94	369081	NPN	—

NOTES: 1. Type 13 can be used for type 33 or 25
2. Type 25 cannot be used for type 33
3. Type 33 can be used for type 25
4. Type 63 can be used for type 83 or 75
5. Type 75 cannot be used for type 83
6. Type 83 can be used for type 75

Voltage Coding and Levels

Color Coding

+12 volts—Gray
−12 volts—Purple
+ 6 volts—Orange
− 6 volts—Brown
−7.5 volts—Blue
−48 volts—White with orange tracer

Voltage Levels

N	+0.4v	− 0.4v
P	−5.6v	− 6.4v
S	0.0v	−12.0v
W	0.0v	−48.0v
T	+6.0v	− 6.0v

Power Supply

A 729 tape unit receives its input power (208-volt, 60-cycle, three-phase) through connectors on the controlling unit. It may, however, be powered directly from wall outlets when not used with the system. Power into the tape unit is controlled by a power on-off switch on the back of the unit and through an interlock relay in the controlling unit to which the tape unit is attached. Three-phase power is used to run the motors, and the DC power supply input is drawn from phases 1 and 2. Figure 96 shows the power input configuration.

Make certain the line voltage is correct for the machine installed. A 729 tape unit wired for 208 volt but connected to 230 volt will operate with a high component failure rate. A 729 having the input transformer for 230 volt will not function properly on 208 volt. The difference is only in the input transformer.

Magnetic Tape Unit DC Supply

The tape unit DC supply is a 60-cycle transistor-controlled power supply (Figure 98). The circuits are in the tape unit Systems 95.00.0; typical circuits are covered here. (Further information is in IBM Customer Engineering Manual, *60-Cycle SMS Power Supply*, Form 225-6478.) The input voltage is regulated by a constant voltage transformer. The output DC voltages are controlled for logic circuits and are merely filtered for other applications.

Ferroregulator

The ferroregulator is a closed, shell-type transformer which includes a magnetic shunt between the primary and secondary windings (Figure 97). Capacitor C1 (Figure 98) across one of the secondary windings

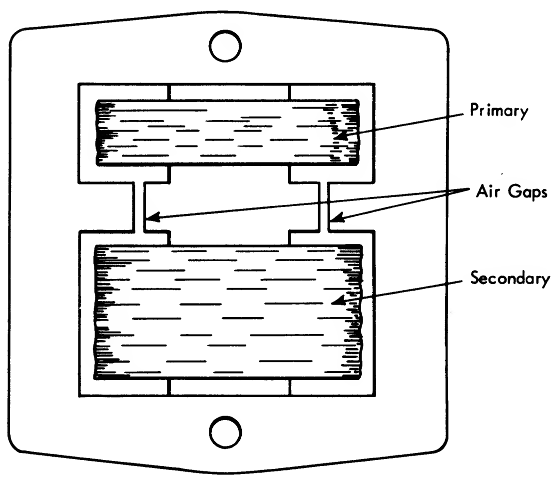
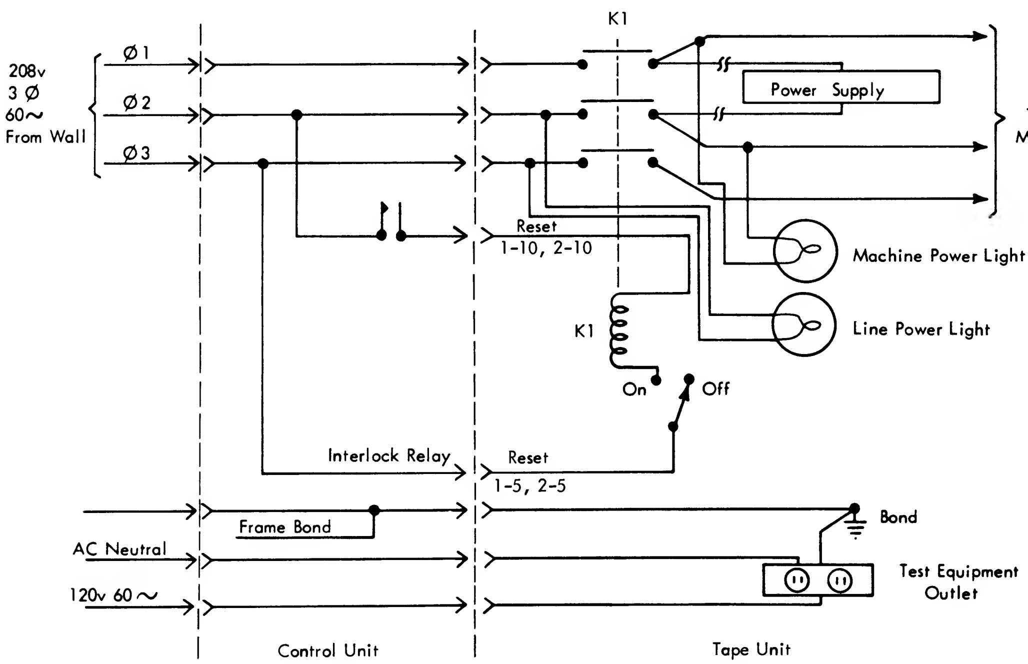


Figure 97. Ferroresonant Regulator Transformer



• Figure 96. Tape Unit Power

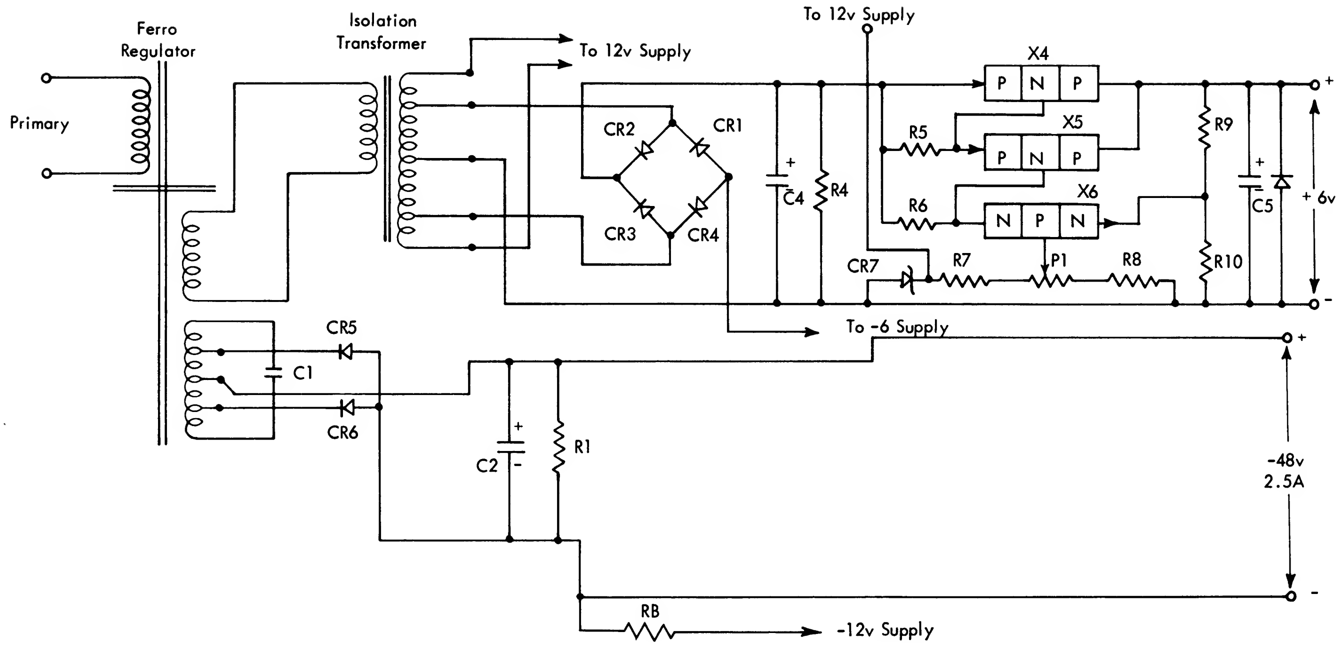


Figure 98. Phase III Power Supply Circuit

forms a ferroresonant circuit. The output voltage is held constant by the use of the shunt in the magnetic path. The shunt path with its associated air gaps allows the rate of flux change (therefore, the developed voltage) to remain substantially constant with variations of the input voltage.

Phase III Power Supply (Figures 98 and 100)

−48 Volt Supply

The −48 volt supply is a full-wave, center-tapped rectifier supply. Only limited filtering is required as this voltage is used in relay and indicator circuits. A bleeder resistor R_B is connected from the −48 volts to the −12 volt supply to help supply the heavier demands placed on that circuit by the additional NOR logic cards.

+6 Volt Supply

The output of one of the ferroregulator secondaries is fed to an isolation transformer that isolates the various outputs from each other. The isolation transformer also allows rectification of several different voltages and polarities. Rectifiers CR 2 and 3 (Figure 98) form a full-wave, center-tapped supply. (Rectifiers CR 1 and 4 are used for the −6 supply, but a bridge configuration is used for the rectifier connections for convenience.) This rectified output is filtered by capacitors C4 and C5 and current is maintained by bleeder resistors. Regulation consists of controlling current flow through power transistor X4 in the following manner.

A parallel path for electron flow exists from the negative side of the line-up through the Zener diode, CR7, and through the resistor-potentiometer network consisting of R7, P1, and R8. Because there is a constant voltage drop across a Zener diode, and therefore across the network, the base of transistor X6 is held at a constant value. Transistor X6 acts as a voltage amplifier to sense a change in output voltage and develop a control signal. Transistor X5 is an emitter follower used as a current amplifier. It takes the control change on its base and develops an adequate current variation to control transistor X4, which is in series with the output power.

If the output voltage tries to increase, due to reduced loading, the following action occurs: there would be a greater voltage drop across R9 and R10. Transistor X6 becomes less forward-biased because the base is held constant by CR7 while R10 makes the emitter more positive. Reduced current flow in X6 shows up as a more positive potential on the base of X5 due to the voltage drop across R6. This reduces the forward bias on X5 and reduces current through R5. Reduced current through R5 means reduced forward bias for X4 and reduces the output voltage as was desired.

Other Supply Circuits

Other voltages in the supply are developed in a similar manner. One is a +140 volt supply for the clutches. A −7.5 volt supply uses a pi-type filter with a choke to handle the heavy current of the prolay drive circuits.

The −6 volt supply operates the same as the +6 volt supply.

The +12 and −12 volt supplies are alike in logic. The Zener diode of the +6 volt supply controls the +12 volt supply and the Zener diode of the −6 volt supply gives a standard to the −12 volt supply also. Remember that there is a voltage drop across the power transistors in series with the output and, therefore, the supply must be capable of rectifying a voltage higher than the desired output. For example, the +12 volt supply could supply about 15 volts without the control circuitry.

Each controlled logic voltage (+12, +6, −6, −12) has a circuit protector in series, and AC circuit protectors are in series with the 208-volt input to the tape unit.

The AC test equipment outlet is powered separately and is not turned off by the power on-off switch on the tape unit.

Power Supply Maintenance

Visual Inspection and Operational Check

Visually inspect the tape unit power supply for loose terminals, broken wires, damaged cables, and leaking or defective filter capacitors. Measure all power supply output voltages and waveforms and inspect functioning of all switches and lights. Check door interlocks.

Open the preamplifier gate and check to make certain the power supply cable has clearance on the power supply shelf. If the cable has been pinched, check the insulation and reposition farther right.

In the 729 II and IV, the ±6-volt and ±12-volt power supplies should not have more than 100 mv drop in the voltage distribution system. Before checking this drop, set the 729 in write status. When the drop exceeds 1 per cent, check the distribution circuitry. Voltages at the power supply should be within +4 and −3 percent for all cases.

There are no finite ripple specifications. The values in Figure 99 are the practical maximums to be used as criteria. Maximum ripple exists with maximum current load. Ripple should be measured with the machine in a static condition to avoid confusion with load variations.

In the 729 II and IV, the circuit protectors are in the power supply series regulators so that any drop across the circuit protector is compensated for.

Cleaning

Vacuum the dust and dirt from the power supply and surrounding area.

Adjustment

Power supply voltage adjusting autotransformers or potentiometers are on the rear of the power supply at the lower right side of the tape unit. Each potentiometer is identified with the supply voltage it controls. See Figure 99 for specifications.

Voltages should be set with the machine in write status. Measure the ±6 volt and ±12 volt lines on the logic panel.

Series Regulated Universal Power Supply

Voltage regulation on this power supply differs slightly from the phase III power supply of earlier models. In this supply (Figures 101 and 102) the YJF-card is used to regulate the ±6 and the ±12-volt supplies (one card for ±6 and one card for ±12). Each card contains two voltage regulator circuits that are identical in every respect.

Circuit Description

Figure 102 shows the essentials of the regulator circuit. To understand circuit operations, assume first that the output is loaded and that the output voltage is tending to drop.

The voltage drop from the chosen reference to the potentiometer remains about constant as a result of a diode-type action of the emitter to base junction of T_4. Thus, the current flowing through this branch stays about the same. Hence, when the output voltage tends to decrease because of loading, the change is felt mostly on T_4.

Because the voltage across the output decreases, current through T_4 tends to increase. T_4 operates as a

Phase III Power Supply

Voltage	Max Ripple (Peak to Peak)
± 6v	15mv
± 12v	100mv
-48v / 2.5 amp	1.5v
- 7.5v / 10 amp	750mv
+ 140v / 1.5 amp	500mv

Universal Power Supply

Voltage	Regulation	Max Ripple (Peak to Peak)
± 6v	+4% - 3%	15mv
± 12v	+4.5 - 3%	100mv
- 48v / 2.5 amp	±10%	1.5v
- 7.5v	±20%	100mv
+ 140v / 1.0 amp	±10% II & IV	4.5v

Figure 99. Power Supply Specifications

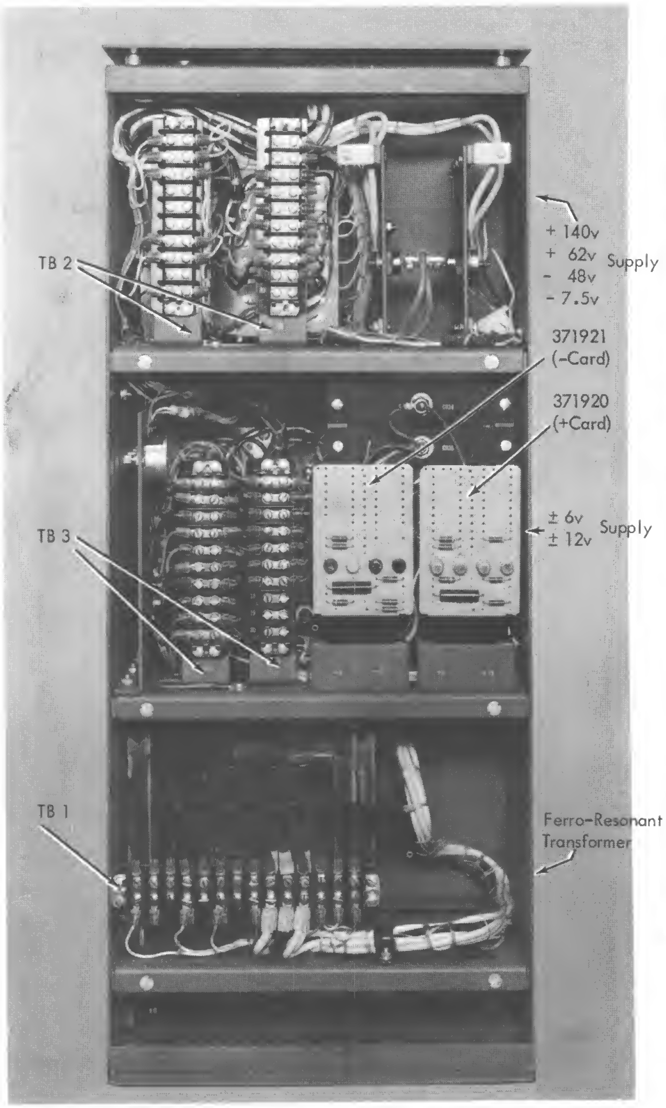


Figure 100. Phase III Power Supply Unit

difference amplifier (amplifying the difference established by the Zener diode reference on the base, and that on the emitter). This increase is coupled to the bases of T_2 and T_3 which amplify the difference. The amplified difference is applied to the base of T_1 increasing its conduction. The opposite action takes place when the output voltage tends to increase.

For higher current applications, T_1 becomes a driver for other power transistors that carry the current load.

Packaging and Servicing

Remember the following facts when service is required on this supply:

1. Each card contains the regulator for two supplies.
2. The regulator card (YJF-) is the same for both ±6 volt and ±12 volt supplies.
3. The most accessible components are those most subject to failure.
4. Ripple specifications are given in Figure 99.

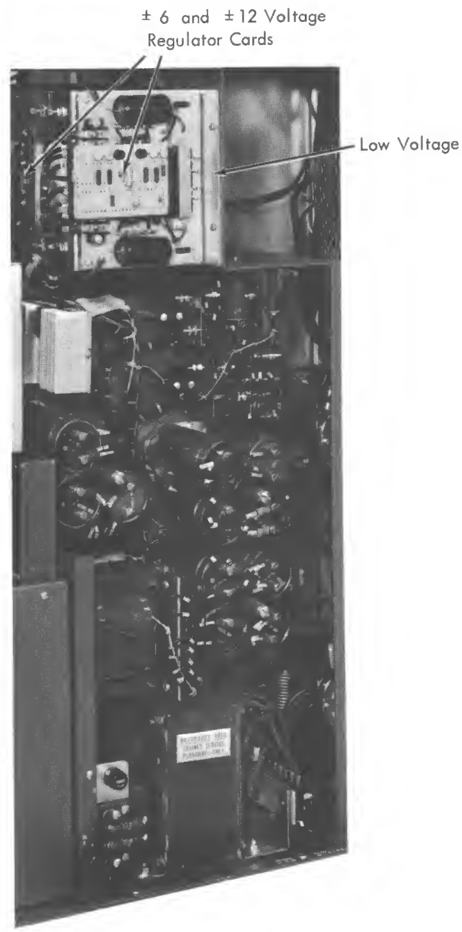


Figure 101. Universal Power Supply

Circuit Protectors and Thermals

Visual Inspection and Operational Check

Refer to Figures 7 and 31.

Circuit Protectors: Check circuit protectors for fault-free mechanical operation and for circuit continuity. Manually actuate each of the AC and DC CP's with power

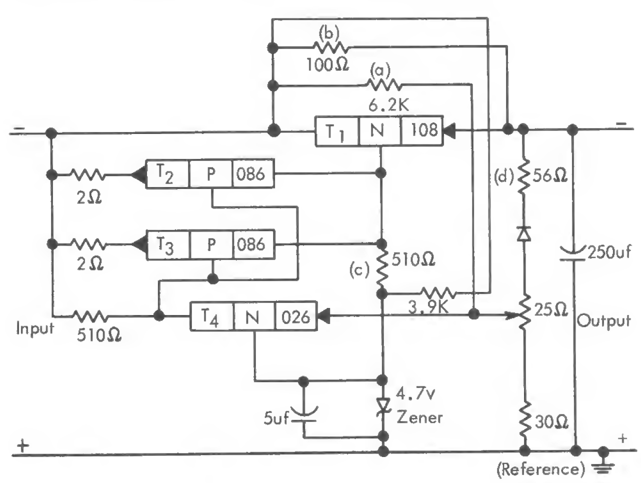


Figure 102. Voltage Regulator—Universal Power Supply

on. Check the power-on contactor for dirty or burned points and trouble-free mechanical operation. Replace faulty circuit protectors.

Thermals: Check the circuitry of the high-speed rewind motor thermal. Use a dummy plug that shorts pins 1 and 2 in the connector of the thermal cable coming from the motor. Substitute this plug for the connector during a high-speed rewind operation. Under proper operation, the tape unit should immediately go into low-speed rewind.

AC circuit protectors 1, 3, and 4 can be actuated by faulty power factor correction capacitors. Be sure to check the PF capacitors before resetting the CP's.

IBM 729 II, IV, V and VI Magnetic Tape Units may be modified to permit switching of tape unit logic between any two magnetic tape channels that are not in operation. The tape unit switches the data and control lines through relays that are manually operated from the IBM 7155 Switch Control Console. Modified tape units may be operated with either of two tape channels of a computer system. See Figures 103 and 104. Possible operation of the modified units include connections between:

1. Two tape channels of one computer system.
2. A tape channel of two computer systems.
3. A tape channel of a computer system, and a tape channel of an off-line system.

The 7155 Switch Control Console controls as many as eight different tape units. Four keys are assigned to each tape unit. Two keys are for a stand-by condition, where the tape unit is not connected to either channel. The other two keys select the channel to which the tape unit will be connected. The depressed key lights up, making it easy to determine the status of the tape unit.

Two toggle switches and 12 relays are added to the modified tape unit (Figures 103, 104, 105, and 107). One of the toggle switches is the remote-local control (R/L). When the R/L switch is in the REMOTE position, the 7155 Switch Control Console controls the tape unit. If the R/L switch is in the LOCAL position, the tape unit is under control of the other toggle switch, labeled A-B. The A-B switch controls the channel with which the tape unit is associated.

The relays are in groups of six, each group control-

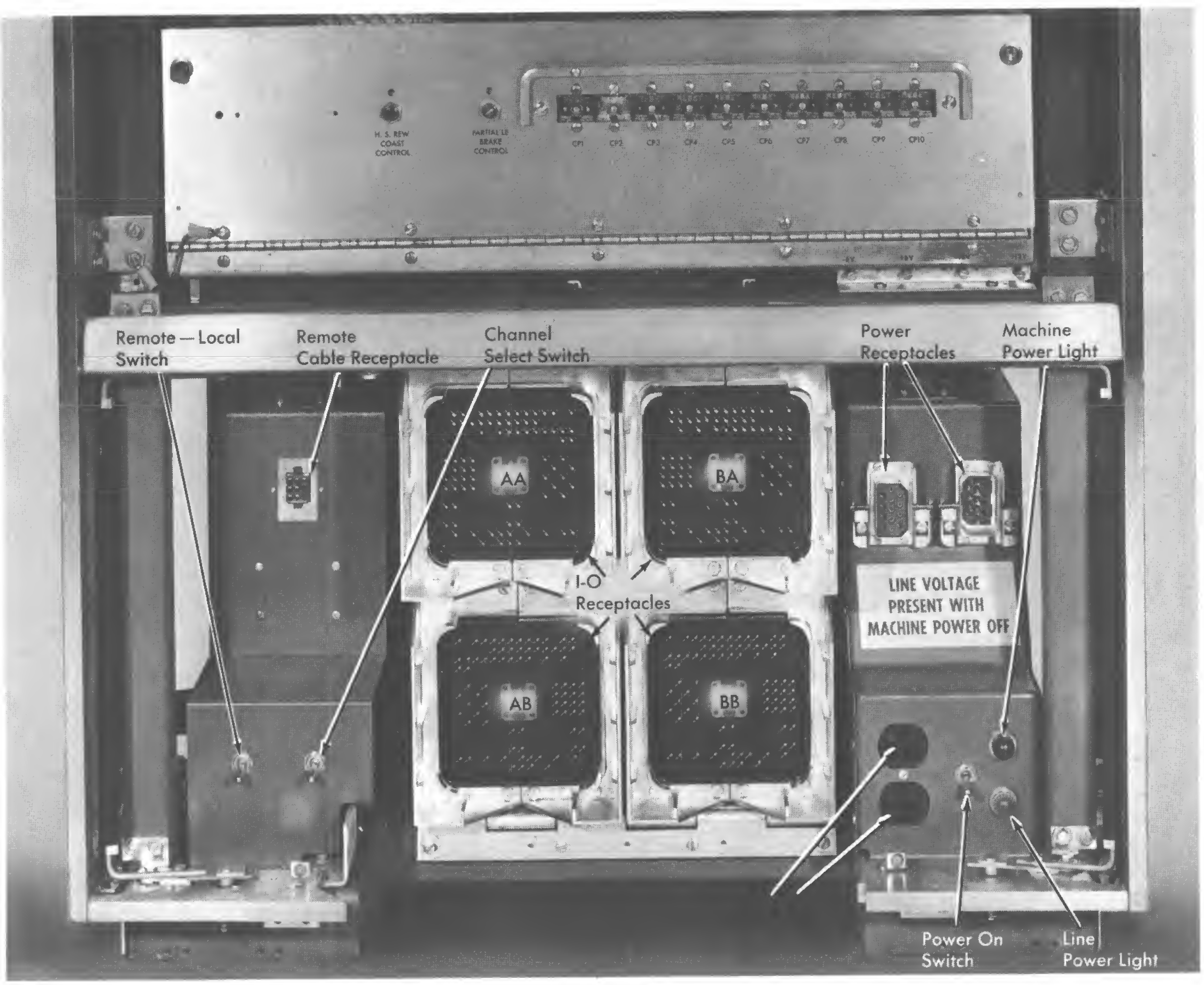


Figure 103. Tape Switching Connectors

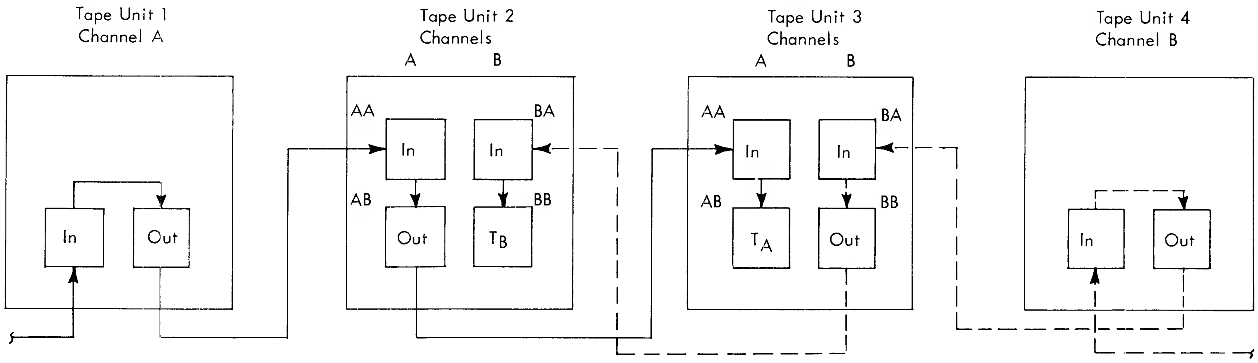


Figure 104. Tape Switching Signal Cables

ling the lines entering and leaving the tape unit. Only one group of relays can be energized at one time. The energized relays select the channel that controls the tape unit.

Dual System Operations

In some dual system installations with tape switching, it may be necessary to drop power on one system and continue operating on the second system. Unless the signal cables are properly terminated, operation on one system is not possible when power is down on the other system. Signal lines for each system must be terminated in a tape unit that has power on.

Figure 106 illustrates one method of connecting the signal cables and terminator shoes so that one system may operate while power is down on the other system.

Operational Check

Circuit Protector Failures—Minus Six Volts: If, after installation of the tape switching feature, the −6 volt circuit protector opens in either the tape control or the tape unit, check the wiring on relay contacts (TP SW relay gate) of R16-11 and R23-11. Only one wire should be connected to the terminals of the normally open contacts. If there are two wires (from TC 14 and 20), the wire from TC14 should be removed and taped back (relay contact end only) to prevent direct connections between the −6 volt power supplies of separate machines.

Floating Signal Shields: If floating signal shields are a suspected source of trouble, perform the following:

1. Clip black wire from edge connector 34H to R23-11. Extend and attach to the R9-7 operating strap.
2. Remove and extend the following wires:

WIRE TERMINATION	OLD POSITION	NEW POSITION
TC20 channel B	R23-11 N/O	R9-7 N/O
TC20 channel A	R16-11 N/O	R2-7 N/O
TC21 channel B	R23-12 N/O	R9-8 N/O
TC21 channel A	R16-12 N/O	R2-8 N/O
Edge Connector 34G	R23-12 operating strap	R9-8 operating strap

3. Fasten wire from TC14 channel B (now taped back in cable) into R23-11 normally open.
4. Fasten wire from TC14 channel A (now taped back in cable) into R16-11 normally open.

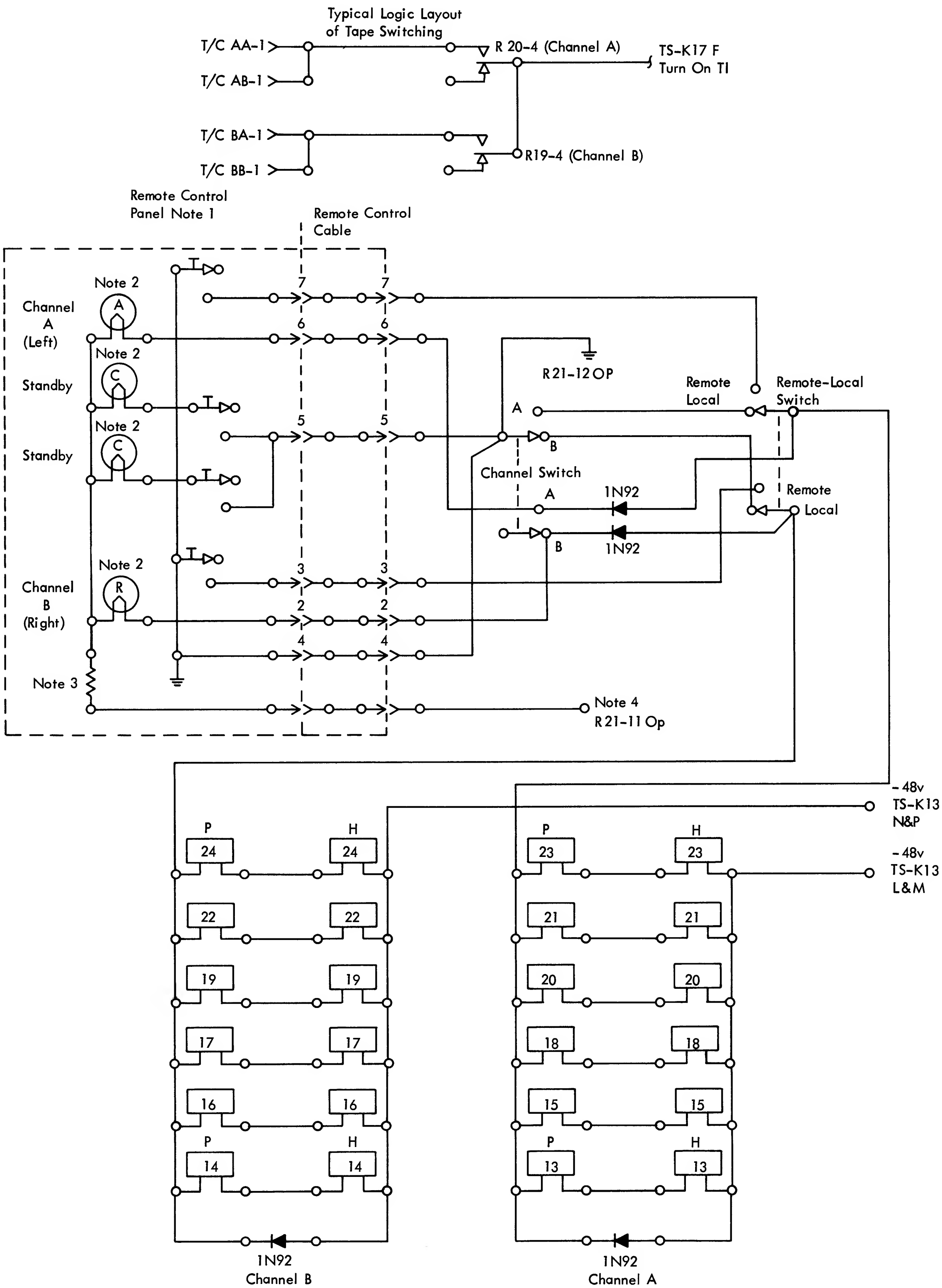
Revise Systems 00.02.3 (P/N 575326) as follows:

TC14: Change Note XI under Channel A to R16-11 normally open.
Change Note XI under Channel B to R23-11 normally open.

TC20: Change R16-11 normally open to R2-7 normally open, and R23-11 normally open to R9-7 normally open.

TC21: Change R16-12 normally open to R2-8 normally open, and R23-12 normally open to R9-8 normally open.

Remove: Note XI.



Notes:

1. Remote control panel switches are interlocked. No two positions can be set at one time.
2. If EC 252267 has been installed on the tape unit, these lamps are 6.3v, No. 349, P/N362119. If the EC has not been installed on the tape unit, the lamps are 28v, No. 327, P/N419974.
3. If EC 252267 has been installed on the tape unit, this is a 10Ω, 2W resistor. If the EC has not been installed on the tape unit, this is a 680Ω, 2W resistor.
4. If EC 252267 has been installed on the tape unit, the voltage at this point is -7.5v. If the EC has not been installed on the tape unit, the voltage at this point is -48v.

• Figure 105. Tape Switching Control Circuit

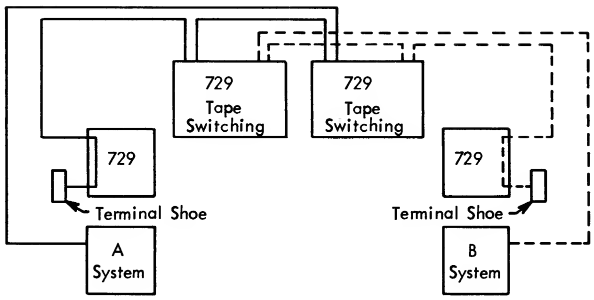


Figure 106. Tape Switching Signal Termination

T/C	Name	Channel A Relay Contact	Channel B Relay Contact
1	Turn On TI	R20-04	R19-04
2	Turn On TI (Shield)	-	-
3	Turn Off TI	R18-08	R17-08
4	Turn Off TI (Shield)	R18-07	R17-07
5	GO	R18-10	R17-10
6	GO (Shield)	R18-09	R17-09
7	Backward	R20-02	R19-02
8	Backward (Shield)	R20-01	R19-01
9	Start Rewind	R20-07	R19-07
10	Start Rewind (Shield)	R20-06	R19-06
11	Set Wr Status	R20-03	R19-03
12	Set Wr Status (Shield)	-	-
13	Set Rd Status	R20-10	R19-10
14	Set Rd Status (Shield)	R20-09	R19-09
16	Reserved	-	-
17	Reserved (Shield)	-	-
18	Spare	-	-
19	Spare (Shield)	-	-
20	Select & Ready M4 (Shield)	R15-11	R16-11
21	Select & Ready M4	R15-12	R16-12
22	Select & TI On(Shield)	R18-01	R17-01
23	Select & TI On	R18-02	R17-02
24	Sel & TI Off (Shield)	R18-03	R17-03
25	Sel & TI Off	R18-04	R17-04
26	Sel & at LP (Shield)	R15-05	R16-05
27	Sel & at LP	R15-06	R16-06
28	Sel & Not at LP (Shield)	R15-07	R16-07
29	Sel & Not at LP	R15-08	R16-08
31	Select & Ready M2	R15-12	R16-12
32	Select & Ready M2 (Shield)	R15-11	R16-11
33	Sel Rdy & Read	R15-04	R16-04
34	Sel Rdy & Read (Shield)	R15-03	R16-03
35	Sel Rdy & Write	R15-02	R16-02
36	Sel Rdy & Write (Shield)	R15-01	R16-01
37	Select & Rewind	R18-06	R17-06
38	Select & Rewind (Shield)	R18-05	R17-05
39	Rewind & Unload	R18-11	R17-11
40	Rewind & Unload (Shield)	-	-
41	Set High Density	R18-12	R17-12
42	Set High Density (Shield)	-	-
43	Set Low Density	R20-05	R19-05
44	Set Low Density (Shield)	-	-
46	High Density	R15-10	R16-10
47	High Density (Shield)	R15-09	R16-09
48	Reserved	-	-
49	Reserved (Shield)	-	-
76	Select TU 0 (Shield)	-	-
77	Select TU 0	R21-03	R22-03
78	Select TU 1 (Shield)	-	-
79	Select TU 1	R21-04	R22-04
82	Read Bus 1	R13-09	R14-09
83	Read Bus 1 (Shield)	R13-10	R14-10
84	Read Bus 2	R13-08	R14-08
85	Read Bus 2 (Shield)	-	-
86	Select TU 2	R21-05	R22-05
87	Select TU 2 (Shield)	-	-

T/C	Name	Channel A Relay Contact	Channel B Relay Contact
88	Select TU 3	R21-06	R22-06
89	Select TU 3 (Shield)	-	-
92	Read Bus 4 (Shield)	-	-
93	Read Bus 4	R13-07	R14-07
94	Read Bus 8 (Shield)	-	-
95	Read Bus 8	R13-06	R14-06
96	Select TU 4	R21-07	R22-07
97	Select TU 4 (Shield)	-	-
98	Select TU 5	R21-08	R22-08
99	Select TU 5 (Shield)	-	-
102	Read Bus A	R13-05	R14-05
103	Read Bus A (Shield)	-	-
104	Read Bus B	R13-04	R14-04
105	Read Bus B (Shield)	-	-
106	Select TU 6	R21-09	R22-09
107	Select TU 6 (Shield)	-	-
108	Select TU 7	R21-10	R22-10
109	Select TU 7 (Shield)	-	-
112	Read Bus C	-	-
113	Read Bus C (Shield)	R13-03	R14-03
114	Spare (Shield)	-	-
115	Spare	-	-
116	Select TU 8 (Shield)	-	-
117	Select TU 8	R13-01	R14-01
118	Select TU 9 (Shield)	-	-
119	Select TU 9	R13-02	R14-02
122	Spare	-	-
123	Spare (Shield)	-	-
124	Spare	-	-
125	Spare (Shield)	-	-
171	Write Bus 1 (Shield)	R23-01	R24-01
172	Write Bus 1	R23-02	R24-02
173	Write Bus 2 (Shield)	-	-
174	Write Bus 2	R23-03	R24-03
175	Write Bus 4 (Shield)	-	-
176	Write Bus 4	R23-04	R24-04
177	Write Bus 8 (Shield)	-	-
178	Write Bus 8	R23-05	R24-05
179	Write Bus A (Shield)	R23-06	R24-06
180	Write Bus A	R23-07	R24-07
181	Write Bus B (Shield)	-	-
182	Write Bus B	R23-08	R24-08
183	Write Bus C (Shield)	-	-
184	Write Bus C	R23-09	R24-09
186	Spare	-	-
187	Spare (Shield)	-	-
188	Spare	-	-
189	Spare (Shield)	-	-
190	Spare	-	-
191	Spare (Shield)	-	-
192	Write Echo	R23-12	R24-12
193	Write Echo (Shield)	R23-11	R24-11
194	Write Check Char	R20-08	R19-08
195	Write Check Char (Shield)	-	-
196	Write Pulse	R23-10	R24-10
197	Write Pulse (Shield)	-	-

• Figure 107. Tape Switching Relay Chart

Characteristics

The IBM 729 V and VI Magnetic Tape Units operate at densities of 200, 556, and 800 characters per inch (CPI). The maximum character rate is increased to 60,000 characters per second (60 kc) on the 729 V, and 90,000 characters per second (90 kc) on the 729 VI. The 729 V and VI perform the same as the 729 II and IV except for this additional 800 CPI capability.

Figure 108 shows characteristics of the 729 V and VI for all densities. The "pair" of densities desired is selected by setting the channel density switch, which governs the character processing rates under either "high" or "low" density operation (Figure 109).

Characteristic	729 V			729 VI		
Tape Speed-- (inches per second)	75			112.5		
Record Density-- (characters per inch)	200	556	800	200	556	800
Maximum Data Rate-- (characters per second)	15,000	41,667	60,000	22,500	62,500	90,000
Character Time-- (microseconds per character)	67	24	17	44	16	11
Average Access Time-- (milliseconds)	10.8			7.3		

Figure 108. 729 V and VI Magnetic Tape Unit Characteristics

Time Asymmetry and Skew

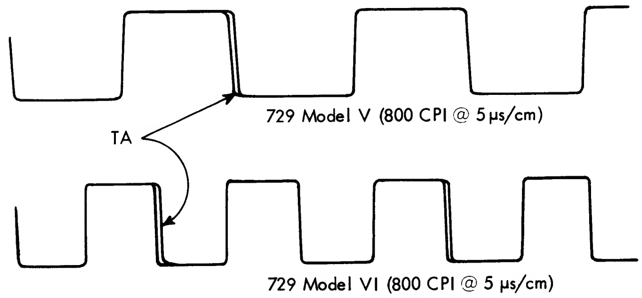
When operating at 60-90 kc densities, both mechanical and electrical skew become more critical. In addition to time differences between different bit tracks (skew), any variation between successive peaks on any single read bus (time asymmetry) becomes a significant cause of skew errors.

Tape Unit Time Asymmetry

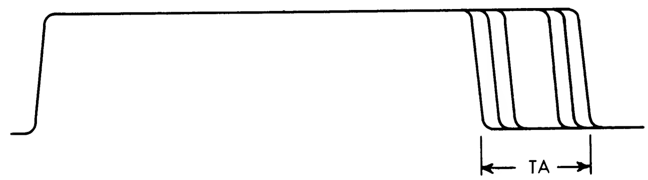
A difference in the current flow through each section of the center tapped write head can cause a time shift when reading successive bits written on a tape. This time difference shows up as a double pulse when scoping the output of a final amplifier (Figures 110 and

Switch Positions		Pair of Densities	729 V Density Mode		729 VI Density Mode	
7080	7090	7070 & 7074	Low	High	Low	High
I	A	556/800	41,667	60,000	62,500	90,000
II	B	200/800	15,000	60,000	22,500	90,000
III	C	200/556	15,000	41,667	22,500	62,500

Figure 109. Density Switch Positions



• Figure 110. "A" Register Waveforms with TA Present



• Figure 111. Expanded Pulse Showing TA

111). This difference in distance when reading sets of pulses written by opposite sections of the write head is referred to as tape unit time asymmetry (TA).

Balancing potentiometers (pots) connected between the write driver cards and the write head coils permit balancing out write current differences (Figure 112).

TAU Time Asymmetry

TAU final amplifiers can also introduce time asymmetry between read pulses as a result of circuit component variations. Balance pots in the ARA card allow adjustment of TA in the 7070/74, 7080, and 7090/94 TAU final amplifiers on systems equipped for 60/90 kc operation.

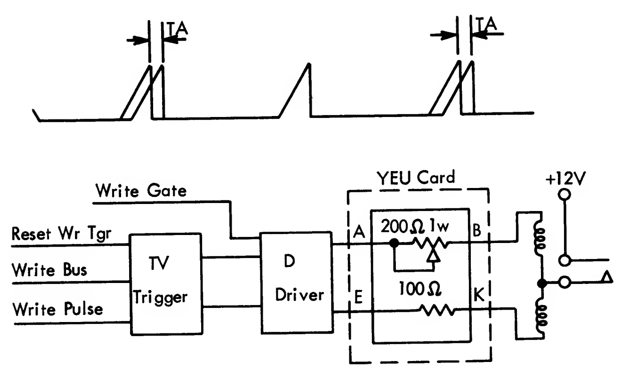


Figure 112. Write Current Compensation

If all of a customer's tape operations were performed on a single-channel system, problems caused by TAU time asymmetry could be taken care of by misadjustment of the asymmetry pots in the tape units. In order to maintain interchangeability between tapes written at 800 CPI on different systems, TAU time asymmetry must be minimized before attempting to adjust TA in individual tape units. Ideally, both TAU and the tape units should be adjusted for zero TA.

729 V and VI Adjustment and Scheduled Maintenance

729 V and VI adjustment and scheduled maintenance techniques are the same as those recommended for the 729 II and IV, except for the additional information that follows. Checking and adjustment should be performed in the following sequence, assuming as a prerequisite that tape unit motion adjustments and TAU clipping levels are set to system specifications.

1. Thoroughly clean tape transport area, paying particular attention to the ceramic guides. They must be clean and operate freely (no binds) if mechanical skew is to be set accurately.
2. Adjust the erase head as outlined in the section "Physical Description and Adjustments." The erase head can cause considerable time asymmetry if set too close to the write gap.
3. Adjust read preamplifier gain to an average of 9.8 volt peak-to-peak while writing at high density (800 CPI). Change density to 200 CPI: the amplitude should not decrease more than 28 percent (below 7.2 volt) for the 729 V, or 22 percent (below 7.8v) for the 729 VI. Try replacing preamplifier cards if these drops are exceeded.
4. Degauss the tape transport area to preserve the accuracy of the master tape. See "Service Aids" section.
5. Check mechanical skew by running the 800 CPI master tape, P/N 461197, and comparing the output of the C and 1 tracks. To preserve its accuracy, make only full passes with the master tape, and rewind it only at low speed. Hold starting and stopping of the master tape to a minimum.
6. Check read skew; it must not be greater than 0.25 μs between negative peaks of leading and lagging tracks. Measure at the read bus, using master tape P/N 461197.
7. After making read skew adjustments, load and unload the tape unit at least five times. After each load operation, scope the skew between the 1 and C tracks while reading the master tape. If skew exceeds 0.5 μs, check for worn or grooved prolay idlers or shafts (flick the idler with the finger tip while watching the scope; skew should remain within limits). Also check the ceramic guides for skew change by flicking each rear flange while scoping. Make sure that the read-write head assembly is not hitting the adjustable head stop block (see "Service Aids").
8. Check for minimum 729 time asymmetry, as described in the following section.
9. After checking for time asymmetry, check write skew; it should be less than 0.25 μs measured between leading and lagging tracks.
10. After adjustment for tape unit TA, the write current must not be less than 37 ma.

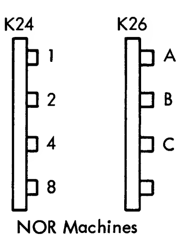
On-Line Check of Tape Unit Time Asymmetry

Check all tape units for time asymmetry and skew every three months, or after replacing a write circuit card or the read-write head itself. On-line TA checks are made while scoping the output of the TAU skew register A triggers (Systems A1.40.20.1 for 7070-74, 7080, 7090/94), using the following procedure:

1. If tape unit TA for any track is suspected of being far out of adjustment, the tape unit adjustment pot for that track should be initially set to mid range (about 100 ohms) with an ohmmeter (Figure 113).
2. Set scope to 5 μs/cm, 1 volt/cm, negative internal sync.
3. Connect probe to output of A register "1" bit trigger.
4. While writing all bits (or all but C bit) at 800 CPI from the tape control unit, adjust scope synchronization to obtain the waveform shown in Figure 110.

NOTE: Increasing sweep speed to two μs/cm will give greater accuracy, but be careful not to expand the wrong pulse in step five. Synchronization adjustment is critical, and should be rechecked frequently throughout this procedure.

5. Using the 5X magnifier, or delayed sweep, expand the first full pulse following the synchronization pulse to obtain the waveform shown in Figure 111. Adjust the horizontal position control so that the width of the "waterfall" can be measured between vertical index lines.
6. Adjust the 1 pot on the YEU card in the tape unit for minimum width of the waterfall (Figure 113). TA should be less than 0.25 μs at the A register output for all bit tracks.
7. Repeat the preceding steps for the remaining tracks.



• Figure 113. Asymmetry Pot Locations

8. Major asymmetry adjustments may require a recheck of write skew.

Off-Line Check of Tape Unit Time Asymmetry (7070/74, 7080, 7090/94)

Two "blank" card positions in 729 IV and VI NOR tape units are wired to accept single ARA and FC--cards, the types used in 7070/74, 7080, and 7090/94 final amplifier circuits. When these cards have been installed, a jumper can be connected to each individual read bus to permit off-line adjustment of tape unit TA. Card positions 3J03 and 3J05 are used for tape units having separate front preamplifier gate; positions 3F03 and 3F05 are used on rear-preamp machines (Figure 114).

Initial Calibration of Test Cards

The ARA card contains an adjustable potentiometer that is set to compensate for TA in the TAU final amplifier. Before an ARA card removed from stock can be used for off-line checking of tape unit TA, it must first be calibrated against a properly adjusted ARA card in the TAU to which the tape unit will be attached.

To calibrate an ARA card:

1. Find or adjust any track of any tape unit to give zero TA when scoped at the TAU A register output, with system ARA and FC--cards installed. Use the same scope setup given under on-line check procedure.
2. Remove the system ARA and FC--cards, and insert the cards prepared for use as test cards.
3. Adjust the potentiometer on the test ARA card until zero TA is again displayed while writing the same track.
4. Remove and mark the test cards, and seal the potentiometer adjusting screw with Glyptal cement.
5. Recheck for zero TA with the original ARA and FC --cards back in the system.

Off-Line TA Check

1. Insert calibrated ARA and FC--test cards in tape unit sockets 2J03 and 2J05 (3F03 and 3F05*), and connect a jumper to the "1"-track read bus output at 2L01H (3H09H*) (Systems TU 07.00.0 or TU 07.00.1).
2. Ground 3H17P (rear logic gate) to activate read gate with CE switch set to off line position. *Be sure to remove jumper before returning tape unit to customer.*
3. If tape unit TA is suspected of being far out of adjustment for any track, initially set the TA adjusting pot for that track to mid range (about 100 ohms), using an ohmmeter (Figure 113).
4. Set scope to 5 μs/cm, one volt/cm, negative internal synchronization.
5. Connect input probe to asymmetry output test point 2J05G (3F05G*) (Systems TU 07.00.0 or TU 07.00.1).

*Rear preamp machines.

6. Insert multivibrator test card, P/N 373305, in tape unit card locations 3C28-3D28.
7. While writing all bits at 800 CPI from the CE panel, adjust scope synchronization controls to obtain the waveform shown in Figure 110.

NOTE: Increasing sweep speed to 2 μs/cm will give greater accuracy, but be careful not to expand the wrong pulse in step eight. Sync adjustment is critical and should be rechecked frequently throughout the entire procedure.

8. Using the 5X magnifier, or delayed sweep, expand the first pulse following the sync pulse to obtain the waveform shown in Figure 111. Adjust horizontal position control so that the width of the waterfall can be measured between vertical index lines.
9. Adjust the 1 pot on the YEU card in the tape unit for minimum waterfall (Figure 111). Asymmetry should be less that 0.25 μs for all tracks.
10. Repeat the preceding steps for the remaining tracks.
11. Major asymmetry adjustments may require a recheck of write skew.

Write Skew Adjustment

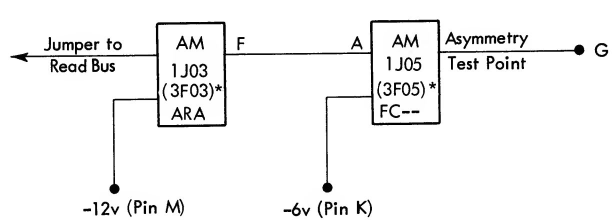
This adjustment is to be made after the write pulse asymmetry adjustment. Write skew shall not exceed 0.25 μs between leading and lagging tracks measured at the read bus after read skew has been set with a master tape.

Write Current

After adjustment for write pulse asymmetry, the write current must not be less than 37 ma.

I-O Connectors

Select and ready for the 729 V and VI is located at TC receptacle connections 114 and 115. If 729 II and IV units are used on the same bus with 729 V and VI units, TC 114 and TC 115 must be connected between receptacle A and B to provide continuity for the 729 V and VI line.



Note: * Indicates card location for rear-preamp machines

• Figure 114. Off-Line Asymmetry Test Circuit

Special Component Circuits

Operation of some transistor circuits in the IBM 729 Magnetic Tape Units may be difficult to analyze from the systems block diagrams. This section shows these circuits in schematic form and contains brief explanations of their operation.

Read Preamplifier

The input to the preamplifier (Figure 115) is a small voltage, about 15 to 35 millivolts peak-to-peak, developed across the read coil by changes in flux as bits are read from tape. The signal level fed to the external control as a result of reading a bit from tape must be 8.8v peak-to-peak. Thus, the over-all gain of the preamplifier must be about 500.

When the input voltage shifts in a positive direction the collector current of transistor T1 decreases, causing the collector to become more negative. This negative shift is coupled directly to the base of transistor T2, causing its collector current to decrease. This results in an amplified positive shift at the collector of T2.

At this point the shift is capacity-coupled to the base of transistor T3, which is held at about 6v by the voltage divider network made up of a 2.7K and a 8.25K resistor between +12v and −12v. The positive shift applied to the base of T3 reduces its conduction, causing a negative shift at its collector. Note that a positive shift on the base of T3 also causes a positive shift on its emitter. This shift is capacity-coupled back to the first stage (T1) emitter where it produces degeneration. The 100-ohm potentiometer in the emitter circuit of T1 determines the amount of negative feedback and controls the gain of the amplifier.

The collector output signal of T3 passes through a delay line (not shown) before it reaches the base of transistor T4. The delay line makes it possible to add small increments of delay to the signal to compensate for manufacturing tolerances in the read head.

The negative shift collector output of T3 is capacity-coupled to the base of T4, driving it more into conduction. This produces a positive shift output which feeds directly into the base of T6.

The emitter follower output stage, T6, feeds the amplified read signal to the external control. The emitter load is in the external control, as indicated in Figure 115.

There is no signal gain realized from the T4 circuit; its function is to act as an isolation stage and allow the output transistor to drive more cable length (capacitance) without oscillation.

Transistor T5 functions as a gate for the preamplifier output. The base of transistor T5 is connected to the junction of a voltage divider. One end of this divider is connected to +12v. The other end of the divider may be either +6v or −6v (read gate). The emitter of T5 is connected directly to +6v. The collector connects directly to the base of T6. When the read gate is at a +6v level, the base of T5 is positive in reference to its emitter and, because it is a PNP transistor, it will be reverse biased (cut off). In this condition T5 appears as a high resistance across the base circuit of T6 and has no effect on preamplifier operation.

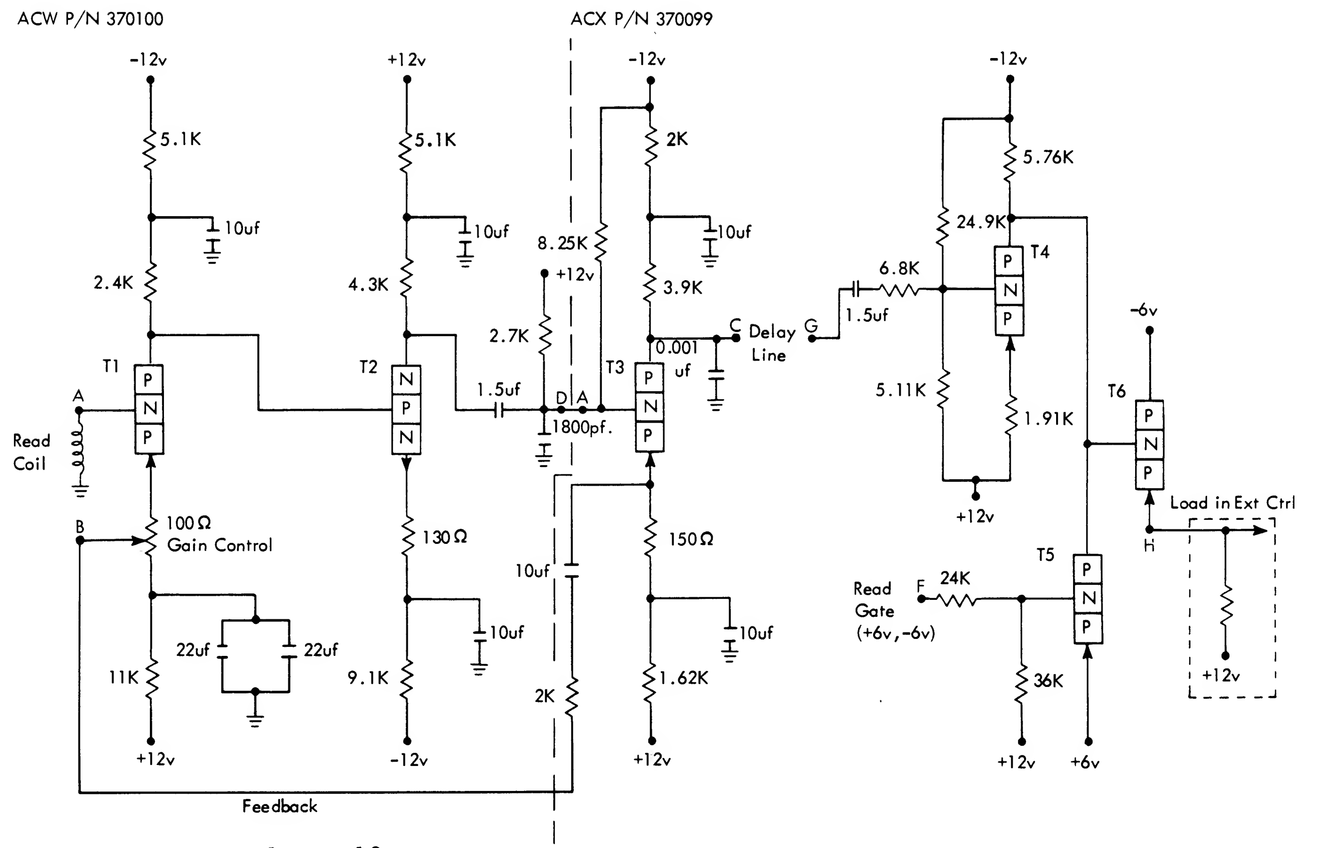
When the read gate is at its down level (−6v), the base of T5 is negative in reference to its emitter (forward biased) and T5 conducts heavily. T5 now appears as a low resistance across the input to the emitter follower and prevents any change in level at this point. This, in turn, prevents any output from the emitter follower stage. The read gate is up (+6v) when the tape unit is selected and ready.

Write Trigger

The write trigger (Figure 116) is a voltage mode, self-gated binary input trigger. Each time a sample pulse (write pulse) is applied to the binary input, the trigger changes its status (flips), providing it is first conditioned by an up level on the gate input.

To understand the circuit, consider transistor T3 conducting and transistor T2 cut off. At this time the voltage at the collector of T3 is 0v. Because the collector of T3 is connected directly to the base of the emitter follower (T1), the voltage level at the emitter of T1 will also be 0v. At this time the voltage divider (R28 and R5) will have about +1.65v at its junction. This positive level on the base of T2 keeps it cut off.

Because T2 is cut off, its collector tends to go to −12v but will be clamped at −6v by the action of the emitter follower T4. The −6v on the base of T4 produces a −6v level on its emitter, causing the junction of the voltage divider (R10 and 11) to tend to go to −2.7v; however, transistor T3 being in conduction clamps the junction at 0v. In this status the left output is 0v; the right output is −6v.



• Figure 115. 729 II Read Preamplifier

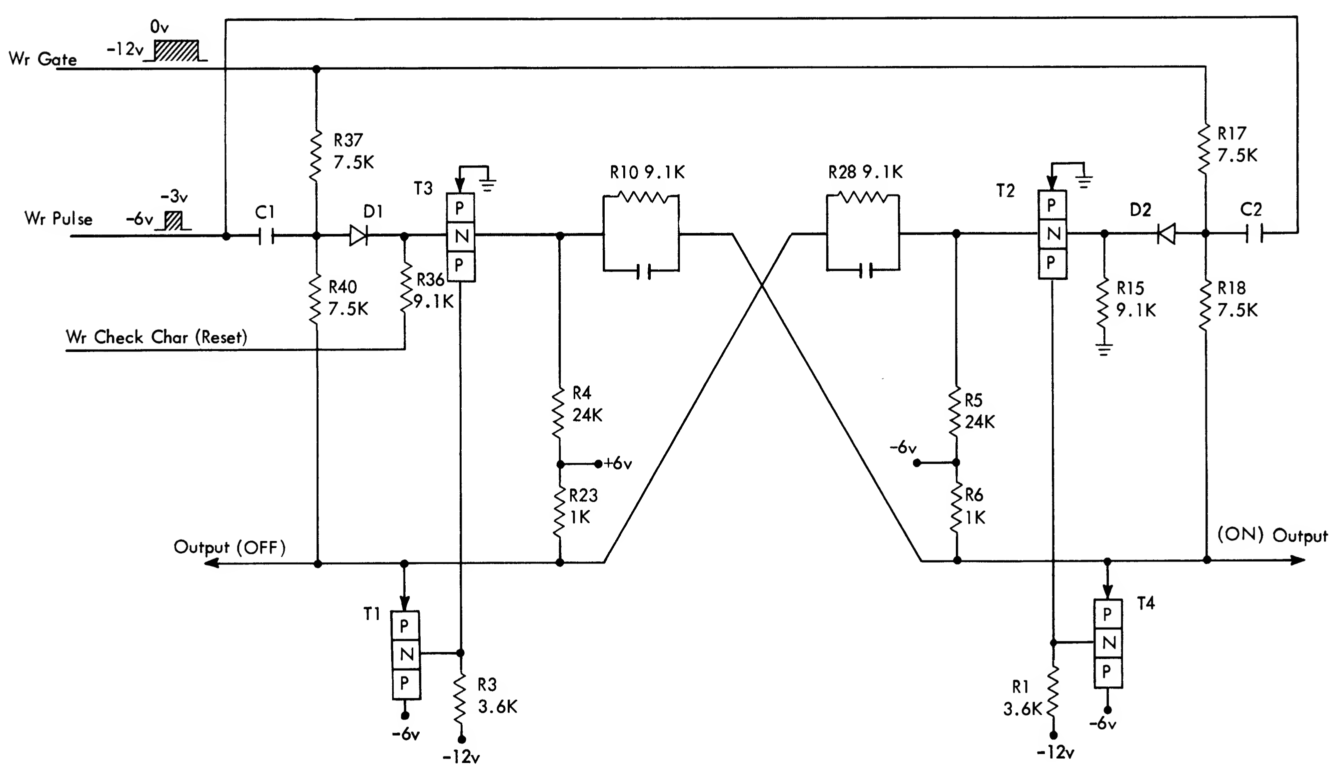


Figure 116. Write Trigger

Before attempting to flip the trigger with a write pulse, the self-gated binary input should be considered. Transistors T3 and T2 each have an input voltage divider consisting of R37, R40, and R17, R18, respectively. The junction of these dividers is connected to the base of T3 and T2 through diodes D1 and D2.

Assuming the output levels previously stated and an up level (0v) on the gate input, the junction of the left input divider R37, R40 will be at 0v. At the same time, the junction of the right divider will be at −3v level.

The write pulse is capacity-coupled to both input dividers through capacitors C1 and C2. Note that when the write pulse occurs, a 3v positive shift will be applied to the junctions of both input dividers. Because diode D2 is reverse biased by about 4.65v (+1.65v cathode, −3v anode), the 3v pulse will have no effect on transistor T2. Diode D1, however, has no reverse bias at this time and the 3v positive shift is applied to the base of T3, cutting it off. As T3 cuts off, its collector voltage drops to −6v, causing the emitter of T1 to become −6v. This action causes the junction of the voltage divider (R28 and R5) to head toward a 2.7v level; however, T2 will conduct, clamping the junction at 0v. With T2 conducting, T4 has 0v on its emitter. This action produces +1.65v at the junction of voltage divider R10 and R11, holding T3 cut off.

The trigger has now changed status and the outputs will be: left output, −6v; right output, 0v. Note that diode D1 is reverse biased and when the next write pulse occurs, it passes through D2, flipping the trigger back to its original status (assuming gate is still up).

Write pulses occur at regular intervals during a write operation; however, we want only a particular write trigger to flip if there is information to be written.

When no information is on the write bus, the gate input (Figure 115) is at −12v for the associated trigger. This holds the junction of both input dividers negative enough to prevent the write pulses (+3v shift) from having any effect on either transistor T3 or T2.

Writing a check character will be accomplished by a reset to the trigger. If the trigger is on just prior to the time the reset occurs, T3 is cut off and T2 is conducting. The negative shift at the base of T3 will cause it to go into conduction and reverse the status of the trigger in a manner similar to that just explained.

Head Driver and Echo Pulse Amplifier

The purpose of this circuit (Figure 117) is to alternately pass current through one half of the write coil, then the other, under control of the write trigger. The circuit also produces an echo pulse each time current is switched in the write coil. The echo pulse is an indication to the external control that a character has been written.

Transistors T1 and T2 have their bases connected to the junctions of voltage dividers and to the right and

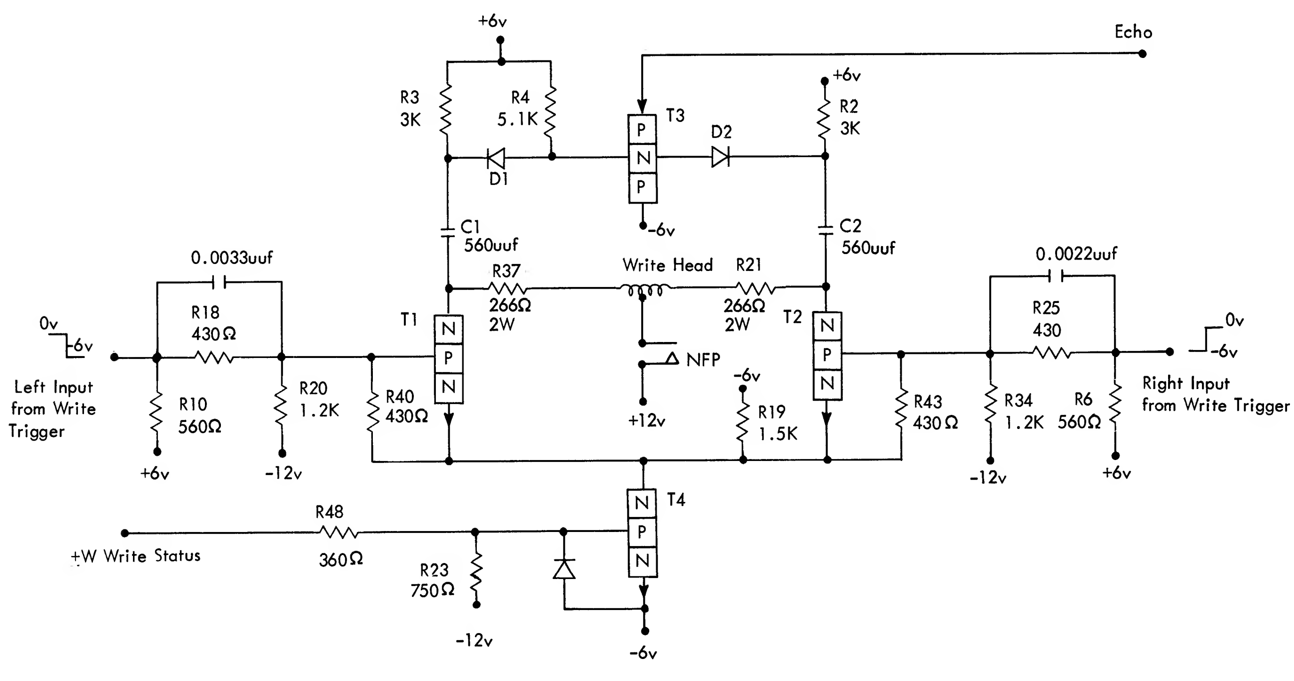


Figure 117. Head Driver and Echo Pulse Amplifier

left outputs of a write trigger; when one input is at 0v level, the other is at −6v.

Note that a third input is connected to the base of transistor T4 through a voltage divider. This input is the write status gate and is above −6v when the tape unit is in write status. When the gate is above −6v, the junction of the divider tends to rise above −6v but is clamped because T4 goes into conduction. Transistor T4 acts as a switch, completing a current path for T1 or T2 to −6v only when the tape unit is in write status. When the tape unit is not in write status, transistor T4 is cut off, causing the emitters of T1 and T2 to be at a +6v. In this state, an up level to the base of either T1 and T2 cannot switch the write transistors.

Consider the following conditions: The gate input is active, thus T4 is in full conduction and acts as a low resistance. The left input is 0v and the right input is −6v. This causes T1 to conduct while T2 is cut off. With T1 conducting, current flows from −6v through T4 and T1 through the left half of the write coil, through the NFP relay contacts to +12v.

As long as current flows in the left half of the write coil, tape is magnetized to one level of saturation. Consider now the operation when the write trigger is flipped. The right input rises to 0v and the left input falls to −6v. This cuts off T1 and puts T2 into conduction. Current now flows from −6v through T4 and T2, through the right half of the write coil to +12v. With current flowing in the right half of the write coil, tape will be magnetized in the opposite direction.

The echo amplifier consists of transistor T3 and its two input circuits. Transistor T3 is normally reverse-biased so it is not in conduction. Transistor T3 has two input circuits: capacitor C1, diode D1, and capacitor C2, diode D2. Coupling capacitors C1 and C2 are coupled to the collectors of T1 and T2, respectively. When T1 conducts, its collector is at −6v; at this time T2 is cut off and its collector is at +12v. When current is switched in the write coil, the voltage at the collector of T1 rises to +12v, while the voltage at the collector of T2 drops to −6v. This causes a positive shift of 18v on Diode D1 but does not reach the base of T3 because of the polarity of the diode. At the same time, an 18v negative shift is applied to diode D2; because this is a negative shift, it reaches the base of transistor T3, causing it to conduct momentarily.

Load Point and End-of-Reel Photosensing

Two identical photosensing circuits are employed in the 729 tape units: one for sensing the load point reflective spot, the other for sensing the end-of-reel reflective spot. These circuits use a photocell that changes resistance when exposed to light. When dark, the photocell acts as a high resistance. When illuminated by light from the reflective spot on tape, the resistance of the cell drops.

Circuit Description (Figures 118 and 119)

The AC photoamplifier consists of an input emitter follower (T1) receiving the signal from the photocell, a Schmitt trigger, consisting of T2 and T3 to shape the input wave, a single-shot at T4, and an output inverter at T5.

Transistors T2 and T3 with their associated resistors and capacitor form a Schmitt trigger. R10 and R11 act as a voltage divider network to establish a reference level of approximately −3.8v at the base of T2. The resistor network of R13, R37, and R36 produces a T3 base voltage of about −1.8v. With the emitters of both T2 and T3 tied to a common point, the transistor with the most positive base is conducting. T3 conducting places its emitter and the emitter of T2 at −1.8v (−2.0v considering a drop across the junction), proving that T2 will be reverse biased and cut off.

T4 in its quiescent state is conducting because of its base being returned to −12v. Resistors R44 and R45 produce a level of about +7.5v at the base of the inverter, T5, cutting it off and giving a −12v (−S) output.

The internal resistance of a dark photocell is high, causing the base of the input emitter follower T1 to be at a minus level and cut off. The type of output from the photocell is conditioned by a number of factors such as tape speed, tape position, and intensity of light. The resulting signal must, however, have an amplitude of 2.5v with the up level lasting for 50 μs.

Reflected light from the TI lamp causes the internal resistance of the photocell to be greatly reduced. As a result, current flows through R27 (current limiting resistor) and causes the base voltage to rise. This, in turn, causes T1 to conduct and pass the input pulse through C1 to the base of T2.

This positive pulse raises the base of T2 above −1.8v and throws it into conduction. At the same time, the emitters of both T2 and T3 rise to the T2 base level, cutting off T3. The increased current flow through R13 causes a negative shift to be felt at the base of T3 via the speedup capacitor, resulting in a very fast flip time of T3 and a well-defined square pulse at the T3 collector.

In the normal state, the collector of T3 was trying to go to −1.8v but was being held to ground by the diode. With T4 conducting, the capacitor C2 has +12v at the right plate and ground on the left. When the

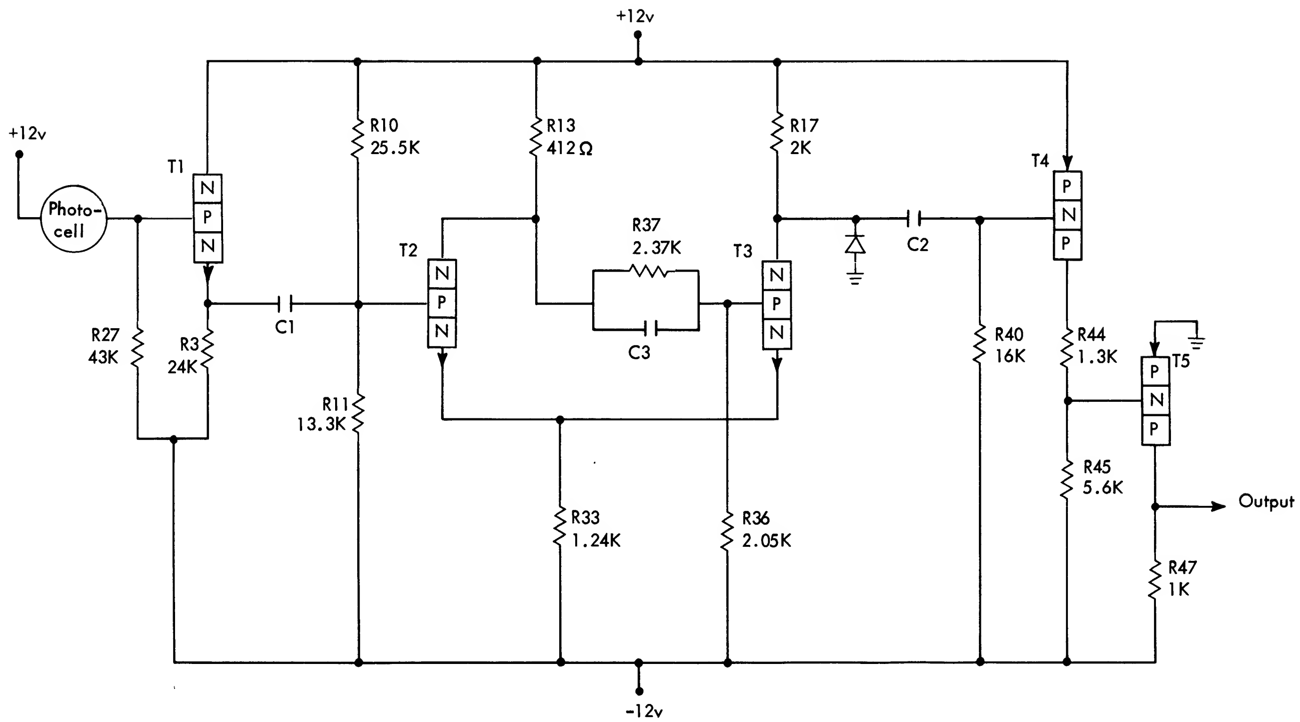


Figure 118. AC Photocell Circuit

Schmitt trigger flips, T3 cuts off and allows its collector to rise toward +12v. A positive 10v pulse (allowing for a drop in the R17 resistor) is then sent through capacitor C2 and to the base of T4. The base rising to +22v cuts off the transistor and allows T5 to conduct, giving a 0v (+S) output.

The diode at this point is reverse-biased and out of the picture completely. The single-shot circuit, T4, times out through R17, C2, and R40, and the base of T4 heads exponentially for −12v (a swing of 34v). As the base approaches +12v, however, T4 again goes into conduction and brings the output of T5 to a −S level. The output pulse is a good 10 μs square wave because the cutoff of T4 occurs on the steep portion of the exponential curve.

CD-- (CTRL Three-way PNP Nontranslating Circuits)

The CD-- card consists of three 3-way PNP nontranslating circuits used for repowering and level setting of CTRL signals. This circuit is sometimes called the NOR circuit. Each circuit on the card performs a basic logic function (+A, −O, I) and inverts the S input signal. The logic function is performed by the input resistor network and the invert function is accomplished by the common emitter transistor configuration. Collector loading for Figure 120 differs from that of Figure 121 and permits flexibility in driving external loads. In the −OR logic application shown, a +S output is obtained whenever a −S level occurs at any of the input points.

Circuit Description

The base of T4 is biased by the voltage developed across the input divider network. The exact level of the bias depends on the number of inputs used and their level. Input levels may vary at their low levels (−S), but all reach ground potential at the +S level. When +S levels exist at all the input pins, T4 base is at +0.65v. The transistor is reverse-biased off as its emitter is returned to ground. Current flow from the −12v supply through the 1.6K collector resistor to the load divider network gives a −10.3v off output.

Dropping any input to the −S level causes T4 base to decrease toward −3.15v. T4 becomes forward-biased on and clamps the base at −0.2v. Saturation current flows through the transistor and quickly raises the output to the +S level (−0.2v). Coincidence of more than one −S level at the input drives the transistor further into saturation and increases the turn-off delay of the circuit.

DOT'ing the collectors (sharing of a common collector load by similar outputs) does not perform another level of logic, but merely increases the number of inputs. These inverter circuits are also combined with other CTRL logic circuits to make up trigger and latch configurations.

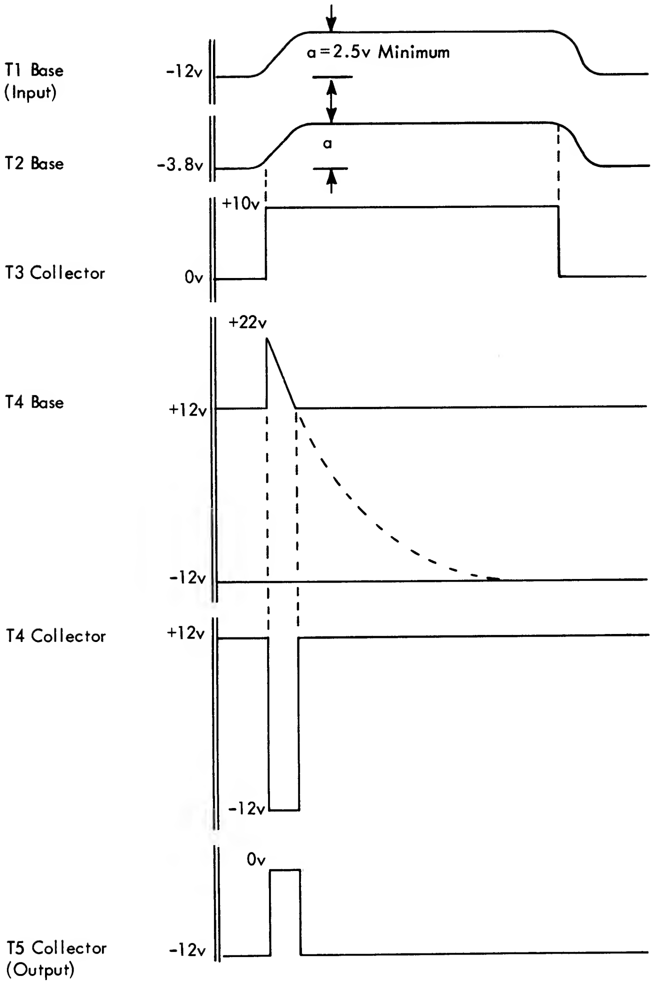


Figure 119. AC Photocell Waveforms

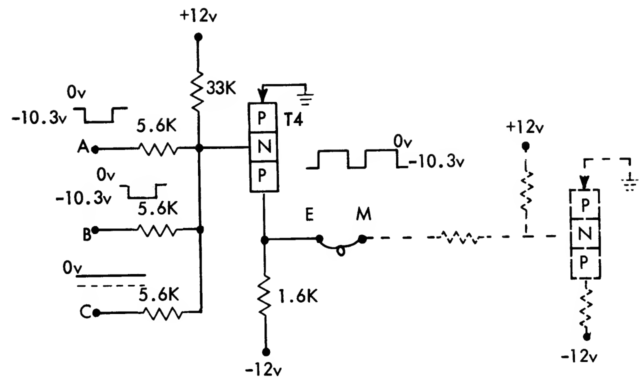


Figure 120. CD - - Circuit Configuration

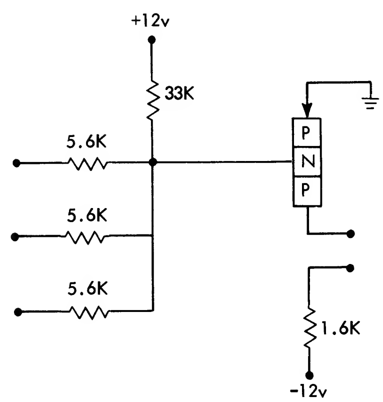


Figure 121. CD - - Circuit Extender